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In order to transform the disruptive forces that threaten the university today into cohesive ones, the university should make structural changes within itself toward a new purpose of enhancing society's capability for continuous self-renewal. It may have to become a political institution, interacting with government and industry in the planning and designing of society's systems, and controlling the outcomes of the introduction of technology into these systems. This new leadership role of the university would provide an integrated approach to world systems, particularly the "joint systems" of society and technology. Chapter 1 of the report identifies pressures for change, relates them to causes which are deeply rooted in society, and attempts to redefine the purpose of the university. The structural and operational aspects of an "ideal design" for the new university that would integrate the disruptive forces of change are presented in Chapter 2. Chapter 3 outlines several innovations that may facilitate the transition from the present to the new design of the university. These include pilot system laboratories, interdisciplinary centers for integrative and policy studies, and the introduction of new teaching and research subjects linking scientific and technological issues to others of public policy and social concern. The report is generally based on the present structure of the Massachusetts Institute of Technology. (WM)

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INTEGRATIVE PLANNING FOR THE "JOINT SYSTEMS" OF SOCIETY AND TECHNOLOGY -- THE EMERGING ROLE OF THE UNIVERSITY

Observations on Some Aspects of the Future of the American University, with Special Reference to the Massachusetts Institute of Technology

by

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Foreword

This report is not an academic's view on current and future problems of the American university. Except as a student, I have never participated in the activities of a university -- and I have spent only one year of my university studies time as an Exchange student at an American university. It was after finishing my degree in Europe. This was 17 years ago. And although I visited this country on numerous occasions, I have never lived in the United States since.

This report was not originally conceived as aiming at the complex problems of the purpose and the structure of the university. A group of M.I.T. faculty members, discussing in a series of meetings future roles for their institution, had selected a number of topics that seemed to merit further exploration, and among them was technological forecasting. My interest in this specific subject, and the fact that I had conducted a survey of its methodology and organization, led to my being brought to M.I.T. for a semester. Realizing that technological forecasting is meaningless if pursued in the isolated frameworks of technological disciplines, I proposed to look into the much larger problem of the university's role in shaping the future, with special emphasis on planning the contributions of technology for that task. Thus, the study project acquired the rather long title which, in spite of its apparent precision, I was able to interpret as an open invitation to formulate, analyze, and tie together many ideas on the future of the university from an "outsider's" point of view -- and I found that this interpretation was heartily encouraged by those members of the M.I.T. faculty who had invited me.

The Spring of 1969 was the right time to be in Cambridge to study such problems. For the first time, open dissent over university policies erupted on the campuses of M.I.T. and Harvard University. In particular, the "March 4" movement and the formation of a faculty "Union of Concerned Scientists" at M.I.T. focussed much wider attention on the blurred purpose of the university. M.I.T. became an environment in which I felt the formulation of constructive ideas to give the university a much more active role in shaping the future was relevant and might find resonance. On the other hand, I was struck by the fact that concerned students and faculty members alike saw practically no alternative to individual and group action by scientists in trying to bring better sense to the introduction and management of science and technology into the context of society's needs and ambitions. It appeared almost as if the institution of the university has become an empty and dispirited framework, which can no more hold and focus the creative energies springing from its community of students and faculty, and to engage in this battle for new purposes of science and technology -- and to change in the process -- would not be worthwhile any more.

It was this relative non-concern over the role of the university as an institution which alarmed me more than the issues that were fervently debated. I was reminded of my first direct and intense contact with problems of the future of the university in my endless discussions with French students during their uprising a year ago, and of their inability to conceive of any but secondary and tertiary measures of university reform, satisfying some of their immediate and short-range ambitions for increased participation. There, the most seriously concerned students' idea of a new university amounted to little else but a replica of the American university as it exists today -- an idea which is challenged in this paper but not nearly enough by students and faculty members everywhere who are demanding university reform. The French students got their American-type university because they did not stretch their imagination far enough -- in spite of the most famous graffitto of the Parisian May of 1968: "L'imagination au pouvoir!" Will the American university also stagnate in its home country because of lack of imagination?

A severe shortcoming of this paper is its lack of detail and elaborate examples. It is not sufficiently articulate to be a blueprint for a new university. It should not be taken as more than an individual's opinion. I am not certain where and to what extent I might just have "talked out of my hat." The time-scale of the study did not permit one to proceed with the three originally envisaged stages, which were: (1) The formation of a loose group of faculty members and students, meeting semi-regularly and providing some kind of "boiling pot" of ideas and analyses; (2) an attempt toward a synthesis and production of a first draft of the report, sent for comment to the members of the group; and (3) the dissection, modification, rejection, or approval of parts of the report by a new series of meetings, and its enrichment by new ideas as well as by details.

As it turned out, it seemed more important to get one person's overall view down on paper first, than to come up with a cross-section of partial views. While I had numerous stimulating discussions with students and faculty members and none with the Administration on this subject, this report is primarily the result of detached and relaxed personal reflection. It will have to stand the test of being discussed by students and faculty members, who all are more expert on specific aspects of the subject than I can claim to be, after my departure from Cambridge.

Apart from the process of critical scrutiny to be applied to this report, I would like to suggest one particular follow-up activity with the purpose of obtaining a clearer and more operational view of some of the crucial innovations recommended: At least four or five entrepreneurs and "careful rebels"[1] among the

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[1] "Careful rebels" are defined by Leonard J. Fein of M.I.T. as concerned people combining compassion with precision.

M.I.T. faculty -- I was able to identify a larger number than required for this step -- should be asked to prepare brief, but precise statements on the tasks, structures, inter-disciplinary requirements, current and anticipated states-of-the-art of methodology and curriculum development, and availability of talent for the proposed system laboratories in several clearly recognized areas of need. Such a step might become the start for an ongoing activity of enriching and refining viable concepts for the future university, proceeding radially in all directions from the central focus provided by this report -- if it is worth that much -- and paving the way for action.

Cambridge, May 1969

Erich Jantsch

INTRODUCTION AND SUMMARY

> There is only one quality more important than "know-how"...... This is "know-what" by which we determine not only how to accomplish our purposes, but what our purposes are to be.
>
> Norbert Wiener

> In human life, design implies the acceptance and even the deliberate choice of certain constraints which are deterministic to the extent that they incorporate the influences of the past and of the environment. But design is also the expression of free will because it always involves value judgments and anticipates the future.
>
> René Dubos

We are living in a world of change, voluntary change as well as change brought about by mounting pressures outside our control. Gradually, we are learning to distinguish between them. We engineer change voluntarily by pursuing growth targets along lines of policy and action which tend to rigidify and thereby preserve the structures inherent in our social systems and their institutions. We do not, in general, really try to change the systems themselves. However, the very nature of our conservative, linear action for change puts increasing pressure for structural change on the systems, and in particular, on institutional patterns.

We are baffled by the sudden appearance of such pressures for change in the educational system by student unrest and by the notion that the current type of education may no longer be relevant. We are confused by the degrading side effects of technology on the systems of human living, in the cities as well as within the natural environment. And we are ridden with doubts about the effectiveness of decision-making processes dominated by short-range and linear thinking and about the piecemeal and passive way in which scientists and engineers respond to them. Through its three functions -- education, research, and service -- the university is deeply affected by all of these pressures for change. To live with them, to absorb them and even make use of them, requires a new purpose and a new structure for the university.

Throughout this paper, the belief is held and substantiated that the disruptive forces threatening the university -- and, indeed, society itself -- may be expected to act as cohesive forces, once a number of structural changes have been introduced, both within the university and in its relationships with society at large and with the various elements of the surrounding community. The penetrating and disquieting argument of student activists, that university reform inherently implies reform of our society, cannot be denied. But of all the institutions being challenged today, it is the university which is called upon to lead this process; no other institution is equally well qualified and legitimized.

It is necessary to deal with causes, not with symptoms. The general concern over the university, and above all the students' concern, cannot be resolved with patchwork and compromising, shock-absorbing strategies. There are no clear-cut problems to be solved -- the classical single-track and sequential problem-solving approach, itself, becomes meaningless today. This may come as a "cultural shock" to our pragmatic and efficient society, valuing nothing higher than "know-how."

The task is nothing less than to build a new society and new institutions for it. With technology having become the most powerful change agent in our society, decisive battles will be won or lost by the measure of how seriously we take the challenge of restructuring the "joint systems" of society and technology -- the systems of which both society and technology are the constituents, systems of urban living, environmental control and conservation, communication and transportation, education and health, information and automation, etc. And the outcome of these battles will depend, above all, on the competence and imagination of people in the key institutions dealing with science and technology: Government at all jurisdictional levels, industry, and the university. They have, in the recent past, acquired some capability for inventing, planning and designing complex technical systems. More than on anything else, our propensity for actively shaping our future will depend on the extent to which and on the pace at which these key institutions -- or entirely new types of institutions replacing them -- will acquire the capability to deal effectively with systems in an integrative way, cutting across social, economic, political, technological, psychological, anthropological and other dimensions. Thus the two key notions are: integrative planning for the "joint systems" of society and technology, and socio-technological system engineering.

Therefore, the leadership role demanded of the university in this vast process of institutional and social change, enforced by mounting pressures and crises, derives from its unique potential for enhancing society's capability for continuous self-renewal. This role must now be seen not only as pertaining to the education function, but to all three basic functions of the university: education, research, and service. The alarming split in purpose and operation among these three functions, becoming visible in the university today, goes down to the roots of its crisis. It blurs the overall purpose of the university.

The Massachusetts Institute of Technology, whose interest and alertness in these matters led to the present study, has pursued all three functions perhaps more vigorously and more consciously, and for a long time in a better integrated way, than most or all other American universities. It is, in the words of its President, Howard Johnson,[1] "a university that has sustained throughout its history an exceptional sense of relevance to its times. Concerned first with the soundness of its scholarship and with the education of its students, the Institute has nourished an innovative interest in the problems of society. And now, perhaps more than ever, it is appropriate that this be so.... A century ago, in a society just emerging from a disastrous civil war, full of divisive problems, confronted with urgent pressures, and with

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[1] Report of the President, Massachusetts Institute of Technology, 1967.

a need to establish and reflect the ideals of a young country, William Barton Rogers' statement of the dignity of useful work and the relation of the ablest young people to the most difficult problems of the time was immediately important." However, this study does not fully concur with the continuation of the statement: "I believe that M.I.T.'s record ...... reflects these directions in a new form, with new purpose, and with continued relevance." Not nearly enough imagination has been applied to ensure this continued relevance. It is becoming ever more evident that M.I.T. has to change thoroughly in the process, if it attempts to maintain relevance to the present and future problems of society.

The major institutional innovations, which this report foresees -- or, rather, hopes for -- in the 1970's, concern the following aspects of the new university:

-- The new purpose of the university is to be seen in its three-fold role in enhancing society's capability for continuous self-renewal: Enforcing the pluralism of society by bringing the creative energies of the scientific and technological community as well as of the young people, the students, fully into play; improving internal communication among society's constituents by translating between the inputs of science and technology on the one side, and society's endangered long-range objectives on the other, and by assessing long-range outcomes of alternative courses of action; and providing positive leadership by working out measures of common objectives, setting priorities, introducing experimental ideas and plans, and, above all, by educating leaders for society.

-- The principal orientation of the activities of the new university will be toward socio-technological system engineering, in particular toward the planning and design of "joint systems" of society and technology, including the long-range forecasting of changes in their structure and pattern and of newly emerging systems.

-- The basic structure of the new university will focus on the interaction between three types of structural units: system laboratories for integrative system planning and design; function-oriented departments, organizing technologies by outcome-oriented categories (functions or missions of technology in the context of societal systems); and discipline-oriented departments as "custodians" of basic disciplines in the physical, life, and social sciences.

-- The operational principles of the new university will emphasize: for the education function a shift from training toward purposeful and useful work, a split into two types of engineering education -- for stationary and for socio-technological system engineers --, and the acceptance of a very big and essential role in life-long education, primarily in the system engineering area; for the research function, the guidance of basic scientific and function-oriented technological research by socio-technological system engineering, and a general shift toward "soft" research; for the service function, the active and integral engagement (as distinct from the current emphasis on passive and piecemeal modes) of the university, the emergence of the system laboratories as "prime contractors" for concerted university-wide or inter-institutional projects; and a shift toward services based less on development than on socio-technological system planning and design.

-- The relationship between the new university and society will become much more active on the side of the university which will emerge as a political institution in the broadest sense, interacting with -- and leading -- government and industry in coordinated efforts to redesign and invent "joint systems" of society and technology. This service will be remunerated in ways which will make the university independent from charity, grants and other artificial and "non-rational" types of support, enabling it to become master of its own science policy (including the funding of basic research).

The most important and absolute overall criterion for designing the new university will be the literal and thorough unification of the education, research, and service functions. The distinction between faculty and students will become increasingly blurred, if this criterion is followed scrupulously. In the system laboratories, they may ultimately interact flexibly in small "profit-centers", with students earning money instead of receiving grants and fellowships.

Self-renewal will also become the guiding rule for the university itself -- for its structures, its community of faculty and students (emphasizing self-education for both and entrepreneurial self-development of curricula and careers), the orientation and means of its research, and the focus of its services.

The question of university government is not treated explicitly. However, it becomes clear that the basic organizational principle for dealing flexibly with complex and highly diversified inputs to planning at the levels of strategic decision-making and policy-making -- decentralized initiative and centralized synthesis -- will also hold for the viable operation of the new university. This will evolve naturally, once the basic shift of emphasis in the method of learning from training toward purposeful and useful work has blurred the distinction between faculty and students to a very large degree.

Chapter I of this report takes what might be called a system analysis approach to the current type of university, identifying pressures for change and relating them, as far as possible, to causes which are deeply rooted in society. On this basis, it undertakes to redefine the purpose of the university.

Chapter II, to continue with the analogy, approaches the "ideal design" of the new university from what might be overstated as a system engineering point of view. It attempts to sketch some structural and operational aspects of a specific design which seems to satisfy the established new purpose and criteria and may be expected to turn the disruptive forces of change into cohesive ones. These aspects are summarized above; they are representative for the proposed drastic departure from the principles and criteria currently guiding the university.

Chapter III, finally, briefly outlines a number of innovations which may be considered as transitory measures to facilitate a gradual evolutionary change from the present to the new design of the university. These innovations include: pilot system laboratories, gradual change from engineering departments to function-oriented departments, interdisciplinary centers for integrative studies and for policy studies, and -- representing measures taken at the smallest possible scale -- the introduction of new teaching and research subjects linking issues of science and technology to issues of public policy and social concern.

This report is not intended, and is not believed, to present a Utopian view of the new university. It attempts to focus on changes which ought to be made in the 1970's.

Also, it does not undertake to predict changes. It tries to contribute a forecast to planning at the strategic level -- the development of a feasible option, consistent with needs and rising pressures which will make themselves increasingly felt in the coming decade. Alternative strategic options ought to be developed and assessed in conjunction with this report.

CHAPTER I. DIMENSIONS OF CHANGE AFFECTING THE UNIVERSITY

I.1. The Blurred Purpose of the University

The modern American university is set up primarily for performing three functions:

-- Education of students;

-- Research -- the enrichment of scientific knowledge;

-- Service to the surrounding community.

It is essential to note that the addition of the second and third functions occurred mainly in our century -- the "research revolution" in the American university about 50 years ago, and the "service revolution" around World War II. Before, the tradition of the American university was largely that of the liberal arts college. This tradition is preserved, or sought to be preserved, today in undergraduate education.

The disruptive forces which become visible today in the form of phenomena such as student unrest, discussions on the structure and the government of the university, on the type of research and services to be performed by the university, and the general dilemma between specialization and generalization in which both students and faculty find themselves, have their roots in the unorganic way in which the three functions of the university were patched together, thereby blurring the purpose of the university.

We may notice a certain "backlash" today, expressing a vague belief that the disquieting problems will go away if the university retreats from its complex involvement with all three of the above functions. Columbia University, in the words of its newly appointed Vice President,[1] will try to redefine itself as "the seat of learning and of knowledge." Part of the faculty of the Massachusetts Institute of Technology profess to a purpose of the university contained in the notion of "the building of intellectual capital and its dissemination". And the President of Cornell University[2] sees the primary purpose of the university in its forming a more or less self-contained community.

This same "backlash" becomes visible in the student demands for a reduction in the university's involvement with government-sponsored research and services. Although it is obviously directed against a specific type of engagement -- contribution to governmental and industrial military-technological objectives -- it carries the danger of turning into a movement against any engagement of the university for the purposes of society, if the latter are expressed through society's representatives, the government.

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[1] Polykarp Kusch, in an interview published by "The New Yorker", 29 March 1969.

[2] James A. Perkins, in the TV debate on The Future of the University, recorded in December 1968.

Another, and ultimately perhaps the most dangerous, expression of this "backlash" is the notion of different purposes for the institution on one hand, and faculty -- or faculty and graduate students -- on the other. In this line of thought, roughly speaking, the institution of the university would recognize only the function of education, and perhaps some "undirected" research, whereas the faculty and graduate students would become involved in most of the research and all of the service functions as individuals, and necessarily through a piecemeal approach only.

At a more specific level, Clark Kerr[1] recognizes a growing conflict between undergraduate education on the one hand, and research, graduate training, and service on the other. He diagnoses this conflict as one between generalization and specialization, as well as between external orientation -- toward the outside community, government, industry, the professions, etc. -- and internal orientation, toward the student. Moreover, he sees a conflict caused by the scale of the total institution within which each function is best performed. This constitutes a very partial view of the illness of the university, and Kerr's recommendation to separate undergraduate education from the rest of the university's functions -- preferably by creating "the cluster college, the relatively small and broadly oriented under-

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[1] Clark Kerr, Toward the More Perfect University, in The University in America, Center for the Study of Democratic Institutions, Santa Barbara, California, 1967.

graduate college within a university" -- pertains only to one aspect of structural change, to the bridging of only one recognized gap. There is no assurance at all that changing the structure in one part of the system will make the whole system healthier.

We have to look at changes, and pressures for change, in all three of the primary functions of the university. We may then, *inter alia*, discern the following important trends:

- *Education*: From training for well-defined, single-track careers, professions, skills, and views towards an education which enables judgment of complex and dynamically changing situations -- in other words, geared to the continuous self-renewal of human capabilities, with emphasis shifting from know-how to know-what;
- *Research*: From discipline-oriented research over multi-disciplinary research toward research on complex dynamic systems -- or, from research on the fundamental level and the perfection of specific technologies to the organization of technology in a system context, in particular, in the context of social systems;
- *Service*: From specialized, piecemeal research contributions and passive consultations to an active role in the planning for society, in particular, in the planning of science and technology in the service of society.

These trends, which will be briefly elaborated upon in the following sections, are in themselves expressions of underlying changes in the relationship between society and technology (and through the latter, science). These changes include the following aspects: the high, and still increasing, rate of technological and social change can be sustained only through active participation; piecemeal approaches, linear and sequential modes of action, are becoming recognized as detrimental to the healthy development of social systems; and, finally, we are finding out the hard way that there is no self-regulating automatism of macroprocesses in the world, and that the "cybernetic element" in the evolution of our planet is man himself and his capacity for actively shaping the future.

It is the basic thesis of this paper that the disruptive forces threatening the university -- and, indeed, society itself -- may be expected to act as cohesive forces, once a number of structural changes have been introduced, both within the university and in its relationship with society in general and with the various elements of the surrounding community. With this process, a new purpose of the university will come into focus. This new purpose will again embrace the three basic functions of education, research, service, but see them in a new light and interrelate them in new ways.

I.2. The Education Function

In the United States, more than 40 per cent of the university-age population are in colleges or universities today; approximately half of them earn degrees. The more than 2000 institutions of higher learning in the United States now accommodate more than 6 million students and employ some 400,000 teachers.

These familiar figures illustrate the extent to which university education will determine the future -- a future which will not simply happen but will be, to an increasing degree, actively shaped by those parts of society that are educated in universities. It is also evident that university education implants values which will perpetuate themselves in society for several decades. Values, implanted by the university today, include, for example: Competition -- by forcing students into the competitive rigour of the grading system; specialization -- not only by the corresponding design of curricula, but also by committing practically all of the student's time to it; professionalism -- by teaching him the "know-how" of professions, without giving him sufficient capability to judge the "know-what"; and efficiency -- by making it very difficult for the student to change from one track of learning to another.

These are false values even today, and may lead to disastrous consequences in the near future -- certainly within the time-frame in which today's students will be active in society. They pertain to a stagnant view of society and give rise to linearity and rigidity, if applied to its dynamic development. Training students for today's professions, is not student-centered education, because the students of today will need to know how to redefine these professions, not how to exercise them. Education for specialized "know-how" encourages the blind application of this "know-how", in other words, the indiscriminate pursuit of feasibilities.

In Robert Hutchins' "The University of Utopia",[1] the "Utopians cannot conceive that the aims of their lives are to produce industrial strength, military power, or more gadgets .... They think that their educational system ought to have some role in helping them to determine what to do with these things when they get them. They do not believe that an educational system aiming at industrial strength, military power, longer life, or more gadgets will, by any stretch of the imagination, help the people learn what to do with them ..... Their hope is to be wise and to become so through their educational system."

We are used to pursuing concrete aims, and in doing so, we frequently confuse future aims with those pertaining to the present. The aims of the education function of the university are just one example for this attitude. But it will not be sufficient to change to static aims of the future, such as education for anticipated

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[1] Robert M. Hutchins, The University of Utopia, The University of Chicago Press, Chicago and London, 1964.

professions of the future, or for future values -- even if we could conceive them correctly today. We have to formulate the aims for the education function in dynamic terms. Even today, in areas of rapid technological change, any "set of professional knowledge" changes several times during a professional lifetime. And the prospects of life-long education, both from a professional and a cultural point of view, are already becoming recognized for the near future.

What we mean by student-centered education in dynamic terms is education for continuous self-renewal of human understanding and capabilities, a propensity for self-education. This implies education for the use of judgment and the development and application of wisdom.

Four educational goals, as formulated recently by Hartmut von Hentig,[1] Germany's leading educational reformer, elaborate this new type of education:

"1. We must learn to think in models, i.e. in general structures, in hypotheses and utopias, separating us from the real world. This is one side of the scientific process.

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1 Hartmut von Hentig, Contribution No. 137 to a roundtable discussion on "Possible and Desirable Futures," Hamburg-Bergedorf, 10 November 1968; published as Protokoll Nr. 31, "Mögliche und wünschbare Zukünfte", Bergedorfer Gesprächskreis zu Fragen der freien industriellen Gesellschaft, Hamburg-Bergedorf, 1969. (Translated from German).

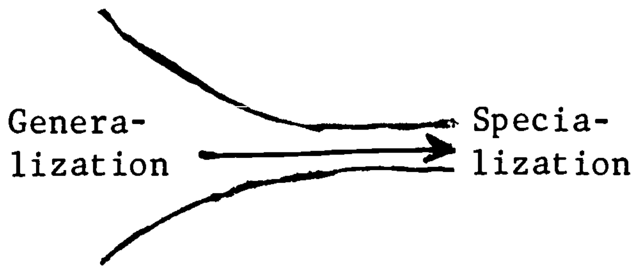
2. We must learn to think in alternatives, i.e., in concepts which are supplemented by the other side of the scientific process, demanding verification.
3. We must learn to think in options, and thereby, above all, in priorities. This implies that we must learn to set targets, because options cannot be worked out before setting targets and making projections.
4. We must learn to think in dynamic processes, i.e., to make decisions and to reverse them, if necessary.

The last two points concern the political moment of our action."

In today's university, the education function is largely determined by two principles: The direction of study proceeds from a more general outlook (in the undergraduate phase) to narrow specialization (in the graduate and postgraduate phases). And the method of learning is by training -- which means that an essentially rigid curriculum (credit system) has to be mastered thoroughly (grading system); the basic idea is to reproduce and multiply professional skills as they exist in the present.

These two principles are used in laying the wrong foundations for the future -- and many students sense it.

The inverted trumpet of current university education leading to increased specialization has a number of serious consequences



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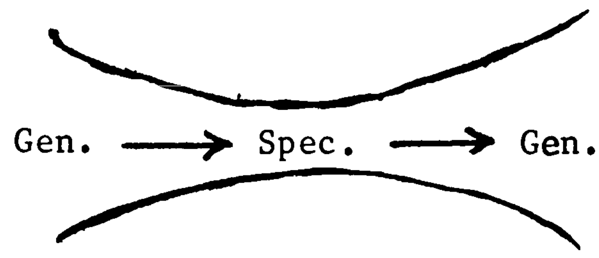

Proposed

both for the student and his future life, and for the direction of technological and social change in general. Adopting the biconcave scheme as proposed above, would amount to changing these consequences in the following way:

-- Students, who are currently prevented from changing the subject of their specialization (or forced to start anew on a specialized track), may develop special capabilities simultaneously or intermittently and keep open a relatively wide spectrum of options of how to apply them in their masters, doctoral and professional work.

-- Students who develop specialized skill in a scientific discipline, will in practical non-academic life become "mercenaries" in the service of multi-disciplinary technical work, and those who develop specialized skill in a specific technology, will become captive to that technology, giving rise to the type of linearity which

Galbraith[1] equates with the emergence of the "technostructure" and its imposition of technological growth goals upon society. The capability to relate special skills to each other and to recognize alternative technological options, will be the prerequisite for guiding scientific and technological development in an active way.

-- Specialization generates input-oriented thinking, generalization encourages outcome-oriented thinking. Only the latter will lead to a rationale for the "know-what" and the application of value judgments to the development of science and technology.

-- As will be elaborated in the following section, emphasis is shifting from technology to the organization of technology, from specific technologies and technological systems to the much more complex "joint systems" of society and technology, which specialists will not be able to grasp.

It can be readily seen that the inverted trumpet shape of current university education, and its basic structural weaknesses derive from different "layers" of values, piled on top of each other in the past

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[1] John K. Galbraith, The New Industrial State, Houghton-Mifflin, Boston, 1967. Although the author believes to describe a model of the present, he points out a danger which is still somewhat in the future.

few decades. While the liberal arts tradition largely prevails for undergraduate education, graduate education moved into focus in the era of the "pragmatic university", perfected in the form of the modern institute of technology. But where formerly most of the students left the university after graduation, and never became so thoroughly specialized, the professionals most likely to influence technological and social change, leave now with a highly specialized outlook and will be employed as specialists. Horizon is traded for excellence, understanding of social responsibility for assets in the professional competition. For the current and future phases of interrelationships between society and technology, the wrong capabilities are acquired in the university.

The specialized knowledge acquired today, apparently does not satisfy the requirements of industry to a large extent. It has been estimated that industry in the United States spends approximately twice the amount of money for educating people than the universities. A large fraction of it reportedly is devoted to re-educating scientists and engineers who come fresh out of their universities. Much of industrial work today requires a system approach, at least to a certain degree, and the capability to fit into multi-disciplinary team work which cannot be assured simply by mixing people from different disciplines.

Moreover, repeated re-education during an industrial career will become ever more important. The task of life-long education should obviously not be left to industry -- or industry will increasingly take over the functions of the university -- but will require new approaches by the university. Scientists and engineers will not come back to the university to change their sets of specialized knowledge and skill, but to learn to deal with complex systems of a technical as well as a social and socio-technical nature.[1]

Particular attention ought to be given to the role of the humanities in the education for generalization rather than specialization. There is a tendency to weaken this role in the undergraduate education of future scientists and engineers. This theme, which will not be pursued much further here, will also involve the high school. It does not make sense, for example, that PhD candidates, in addition to working for their thesis and preparing themselves for the examinations, should stuff some superficial knowledge in one or two foreign languages into their head -- and forget it quickly afterwards -- instead of acquiring a thorough proficiency in at least one foreign language in high school. Here, the European example ought to be studied.

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[1] The Center for Advanced Engineering Study at M.I.T., which accepts every year 50 people from industry and government for a year of re-education, focusses on system engineering and system analysis.

What students, and most members of society, also lack to a very high degree, is some sort of sensual education in the broad meaning which Marshall McLuhan[1] wants to give it. As we increase our capacities of transforming the world around us, we become ever less capable of bringing aesthetic values to our creations. This obstructs our view of the future, because we turn to the past for its aesthetic values. We become passively submerged in and conditioned by our technology-dominated environment. The gap between functional and aesthetic creativity becomes most evident in engineering and in management education today -- in other words, in those areas where "efficiency" in a narrow sense governs education.

The second basic principle in today's university education is the <u>method of learning by training</u>. It is the method best suited for a static approach -- duplicating existing skills -- and for specialization. Some of the restless students will perhaps also point out, and correctly so, that it enshrines an authoritarian approach to teaching and learning. One may even hesitate to call it education.

Many university teachers today recognize that students have an urgent desire to do <u>purposeful work</u>. The growing feeling among students that education is irrelevant in the light of the problems with which society is faced, and by which students are becoming deeply concerned, has much to do with the method of learning.

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[1] Interview with Marshal McLuhan, <u>Playboy</u>, March 1969.

It will not be sufficient to just re-orient the method of learning toward more purposeful work. PhD work, and a sizeable portion of work for the Master's degree may already be called purposeful work. But it consists either of one-man jobs, solving some piecemeal problem, or of contributions to complex technical system developments. Even very broadly conceived system engineering projects, in which students may participate in the framework of their study, or as research assistants, generally focus more or less on purely technical objectives.[1] Essentially, the problems of society, as far as they enter university education at all, are not tackled by universities in a way which would give students the possibility to do work which they consider meaningful for these problems.

The degree to which education will contribute to fostering the propensity for continuous self-renewal, will depend to a very large extent on the type of challenge to which the student is encouraged to respond. We are beginning to understand that narrowly conceived cycles of challenge and response -- by accepting such types of challenge as obtaining a degree in university, or profit maximization

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[1] Project MAC at M.I.T., an Institute-wide research effort in the computer sciences, a pioneer in the field of time-sharing multiple-access computer systems, and aiming further at machine-aided cognition, presents to most of its contributors a primarily technical challenge. It is interesting to note, that in the "computer-oriented institution", as M.I.T. calls itself proudly, the most extensive and imaginative use of computers is made in the Department of Civil Engineering.

in industry -- perpetuate linearity, inability to deal with systems at the level of society, and the dullness of materialistic values. The dominating value, competition, is but a surrogate, impoverishing our life, for the vitality of the response to more imaginative types of challenge. The broadly conceived and complex challenges of modern society, and of responsibility for mankind as a whole, are of this type.

A similar urge for relevancy, and for doing purposeful work, makes itself felt in the demands of undergraduates. Clark Kerr[1], who may be considered a specialist in the reform of undergraduate study, lists among specific remedies within the existing university structure the following improvements of undergraduate education: freshmen seminars, credit for field study and other extra-university activities, spreading of liberal or general education throughout four years instead of the usual two and perhaps even into the graduate level (sic!), introduction of pass-fail grading to encourage broadening of the student's study programs, courses specifically designed for the non-major, more opportunities for independent study, introduction of "problem-oriented" as well as survey courses, easing of methods for students to drop and resume their studies, and more effective machinery for the encouragement and approval of new and experimental programs.

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[1] Clark Kerr, Toward the More Perfect University, in The University in America, Center for the Study of Democratic Institutions, Santa Barbara, California, 1967.

Summarizing the pressures for change in the education function, we may group them under the following three headings.

1. The university ought to provide a type of education which emphasizes the student's capability of continuous self-renewal in his life, not the transfer of an existing body of knowledge.
2. University education, invariably leading to specialization today, ought to provide alternatives leading to broad generalization.
3. The method of learning in the university ought to change from its present emphasis on training toward increasing emphasis on purposeful work contributing to solutions of the problems of society.

I.3. The Research Function

The research function of a university, of course, cannot be dealt with in isolation. Or, at least, it should not -- because it is a fact, and a matter of growing concern in the American university, that the gap between the education and the research functions is rapidly widening. One may recognize two principal underlying causes for this. Both have to do with the institutional rigidity of the university, especially with respect to its education function, which led research and education to develop along individually conceived lines becoming more and more separate. Above all, this is the fault of the discipline-oriented structure of the education function,[1] and of policy-making in the university.

The <u>first</u> cause may be found in the <u>sociological aspects of academic research</u>. Research is of the highest importance -- higher than educational achievement -- in gaining the types of status and reward attached to the academic career. Status in the institutional and scientific community can usually be gained only by contributing to the contents of recognized scientific and technological disciplines. Academic rewards -- appointments, tenure, etc., -- also are largely allocated within the boundaries of disciplines. Thus, a certain rigidity in university structures is not only imposed upon the faculty, but also firmly anchored in the growth objectives of individuals.

The usual half-hearted approach of the American university to break out of this vicious circle, is the creation of inter-disciplinary centers. There, it is thought, faculty and graduate students may find

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[1] It is significant to note that not even the creation of Departments of Economics, and of Political Science, at M.I.T., the country's foremost technical university, led to substantial research which might be relevant to problems of our "Technological Age", e.g., in areas such as technology and economic growth, the micro- and macromechanisms of technological innovation, or science and public policy. Nor did the establishment of a School of Humanities and Social Science at M.I.T. foster significant research on the cultural implications of the "Technological Age."

a "second home", as it is called at Columbia University, to pursue their broader interests. But the center cannot offer any rewards in the above sense. Above all, it cannot offer academic careers; it is an appendage to the university, not part of its system. M.I.T. does have Professors of Urban Affairs -- but they are visiting outsiders, who have not grown in an academic environment.

Being weak in their institutional role, depending on the part-time interest of people pursuing specialized academic careers as their principal goal, lacking focus in their system approach, and frequently falling back on piecemeal, if inter-disciplinary, research, the center has generally become passive and not much more than another source to obtain research support. It may, nevertheless, play an important role in a transitional period in which so much will depend on having at least a limited number of faculty available to start more broadly oriented approaches of the university and deal with the type of social-technological systems which will come into the focus of research as well as of learning.

The second, and more important, cause for the gap developing between the education and the research functions is inherent in the changing nature of research itself, or, better, in the enrichment of the dimensions of research. It is perhaps useful, to look at the problem by distinguishing four steps of a logical and historical evolution in the nature of research, which also mark a progression in complexity:

Research in basic scientific disciplines:

Research in technologically-oriented disciplines;

Research in the organization of scientific and technological knowledge for the purpose of engineering complex technical systems;

Research in the organization of scientific and technological knowledge for the purpose of engineering "joint systems" of society and technology.[1]

University structures were successfully developed to integrate the education function with research pertaining to the first two steps only. The classical European university with its broad and clumsy structure of four or five faculty units and the academic chairs serving the disciplines focusses on the excellence of research by the individual holders of the academic chairs. The department system of the American university improved substantially the basis for broader research programs and for team work. The modern institute of technology depends even more strongly on the department

[1] For an elaboration of the concept of "joint systems", see, for example: Erich Jantsch, Integrative Planning of Technology, in Perspectives of Planning, OECD, Paris, 1969. It is a simplification to look at technology only in the context of the "joint systems" it forms with society, but it serves the purposes of this paper in sufficient approximation. More elaborate concepts would have to recognize interactions at least between man, society, nature, and technology.

system and on the possibility to group multi-disciplinary scientific knowledge within technologically-oriented structures.

Relationships between education and research has become much more complex, however, and in many cases has led to "alienation" between them, when university research moved to the third step, to organizing scientific and technological knowledge for the purpose of engineering complex technical systems. The "alienation" was furthered by the fact that the bulk of this type of research was carried out in the defense and later in the space areas, characterized by requirements of classification as well as of industrial-type "efficiency" and timeliness with which it was difficult to match the requirements of educating students.

But the decisive elements in this process of separation may be seen in two aspects of modern multi-disciplinary research projects: (1) Their boundaries usually transgress the boundaries of established scientific or technological teaching departments; and (2) they frequently embrace all phases of technological innovation, up to development, advanced and prototype engineering, and even testing. Whereas the earlier phases -- which may be called discovery, creation, and substantiation -- pertain to scientific and technological research proper, the later phases represent essentially industrial activities and may be more readily justified under the heading of the service function, giving a particular type of service including, for example, hardware development.[1] Whereas student participation in this type of technical project may still be called good training for the industrial environments in which he might find himself after leaving the university, it has little to do with education stressing the development of the creative capabilities of the student.

In fact, many research laboratories dealing with projects of this type, although originally founded and possibly administrated by universities, have been set up as "buffer institutions" of various types. These types range, for example, from the on-campus Instrumentation Laboratory of M.I.T., over the off-campus Lincoln Laboratory of M.I.T., all the way to the Institute of Defense Analyses, set up jointly by a number of universities, and the Brookhaven National Laboratory, set up and administrated by a consortium of universities. They all illustrate, to a slightly differing degree, the split between the research and the education functions. Few, if any, faculty members work there or spend periods of time there; few, if any, students do their thesis research there. There are few social relationships between the university community and the laboratory staff, mostly regarded as "the hired guys" and strange to the community. In short, there is little which the education function

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[1] In the following section I.4., it will be doubted, though, that this type of service belongs to the legitimate function of the university.

gains, which it could not in an equal or better way obtain from some interaction with industry.

It is interesting to note that research and education can be brought together in a much better way in those applied laboratories or research programs which fit within or gravitate naturally toward an educational department.[1]

It constitutes one of the basic arguments of this paper that by moving on to the fourth step of the research evolution -- to research in the organization of scientific and technological knowledge for the purpose of engineering "joint systems" of society and technology -- a new, intimate and natural bond between the education and the research functions may be developed.

It is increasingly recognized that technology has to be considered in the context of the systems in which it becomes effective, in particular, in the joint systems formed by society and technology. Such joint systems may be defined by the functions technology fulfills for society, and can be enumerated in need- or outcome-oriented categories, such as (to name only those which are at present in the foreground of public interest) transportation, urban living, environmental control, environmental health, communication, automation, information, food production

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[1] At M.I.T., examples are the Electronic Systems Laboratory, in which permanent, "hired", staff mixes with faculty and students, and the interdepartmental Project MAC -- both of which grew out naturally from the Department of Electrical Engineering.

and distribution, power generation and distribution, education, defense, exploration, etc. These categories may be further broken down by technological missions. Few of these outcome-oriented categories either match university departments,[1] or can be fully accommodated within a department.

Planning for these outcome-oriented categories, including that for scientific and technological development, ought to follow what is primarily social criteria. Planning which cuts across a multitude of dimensions inherent in such a system -- in particular, social, economic, political, technological, psychological, and anthropological dimensions -- has become known as integrative planning. Integrative planning is, above all, planning in terms of the quality of life.

Research of the fourth type thus represents a new type of interdisciplinary enterprise and a new and challenging task for the system sciences in a very broad sense. It constitutes a drastic departure from the rationale applied so far to scientific and technological research which focussed on the logic inherent in this research -- search for "truth", for the "new", etc. -- or on the outcomes of technologies as forecast in the light of single system parameters only (such as performance or economic estimates).

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[1] An exception is, for example, M.I.T.'s Department of Nutrition and Food Science, which may flexibly accommodate all scientific and technological disciplines of relevance today or in the future.

Research of this type will not only give an entirely new meaning to the service function of the university (see the following section), but will also provide a rationale for the restructuring of the education function -- a rationale that satisfies the criteria and pressures for change which are becoming visible for the education function and which were summarized in the preceding section. It will provide the students with opportunities for meaningful, creative, and critical "close to life" work which will be a research and creative contribution while being education. Such work will enhance the student's capability for continuous self-renewal.

This unique opportunity to bring the education and research functions together again, has been recognized by M.I.T.'s Assistant Provost who is reported to have said[1]: "Educational self-sufficiency" will become a fundamental goal of the educational program. It is now clear, he said, that "we educate in direct proportion to the innovativeness and critical power which we can give to our students." Because we cannot be sure of the professional environment in which they will work, our students need especially the ability "to dissect new situations, to decide what and how to learn on their own." To provide this innovative ability, said Professor Gray, we must blur and eventually eliminate the line between teaching and research; the

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[1] Paul E. Gray, at an M.I.T. Alumni Meeting in Boston, end of 1968, as reported in the editorial article "Freshening Winds of Change", in Technology Review, February 1969.

character of both must change so that they in fact become one .... In the same sense, education must become relevant to the students' -- and to society's -- needs, which are in fact one and the same. "Students are asking that institutions accept responsibility for the relevance of their education and of the institutions' goals to the ultimate needs of society," he said.

The coupling between research of all four types, outlined above, will be a task of primary importance. But it is essentially not a new task for the university. As research moved to the second and third step, it was always the later step which "led", guided and organized research at the earlier steps in this normative process. Research in technology spurred and guided research in basic science; research in complex technical systems did the same for research within technological disciplines.

With the growing impact of science and technology on society, the university became an important factor in social change. But this role was never explicitly recognized by the university. On the contrary, the notion of "academic freedom" -- originally conceived as the basic freedom to pursue and make known scientific truth -- was frequently evoked to reject any formal responsibility of the university vis-à-vis society. The myth of "free", unguided research leading to scientific results of optimal benefit to society was created, and up to this day defended with considerable success -- in Europe to an even higher degree than in America. Thereby, a very dubious belief in one more automatism in the macroprocesses affecting society took hold, taking its place besides the belief in economic, social and political automatisms that all have to be discarded today by a rather tedious process of study and persuasion.

As René Dubos[1] points out, the bulk of scientific progress was probably always achieved in response to implicitly recognized social needs -- but the principle of guidance by social criteria was hardly ever openly accepted by scientists. Today, we begin to realize that we need much more elaborate and explicit assessments and integrative studies to provide meaningful and effective guidance.

It will be necessary to keep the different types of research, enumerated in the four steps above, separate conceptually, as well as perhaps with regard to their place in the education function and in university administration. They must be well coupled, but they must not dissolve in each other. This may be justified, if by nothing else, just by some sense of caution. We do not yet know what will happen to scientific disciplines with all of their well-ordered body of knowledge and their theoretical structure, once they enter the critical process of dissection in the light of society's

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[1] René Dubos, Future-Oriented Science, in Perspectives of Planning, OECD, Paris, 1969.

present and future values. We do not know whether we will have the wisdom and the self-discipline to maintain criteria of scientific clarity and truth under the pressures of social crises.[1]

Certainly, the departments of basic science in a university should not be structured in terms of social need categories -- the same also holds for industrial basic research laboratories. But faculty and students of these educational departments should have a wide opportunity to participate in research on the "joint systems" level, flexibly interacting with structures in the university devoted to this type of research. And, of course, the scientific disciplines themselves may eventually feel a need to redefine themselves, with the content of many disciplines of science now being reformulated in terms of basic energy principles and of concepts developed by physics.

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[1] This point was emphasized, for example, by M.I.T.'s President, Howard W. Johnson, in his lecture on "Educational Requirements in the Industrial World", given at the Technical University (ETH), Zurich, Switzerland, on 16 January 1969 (Neue Zürcher Zeitung, foreign edition No. 17 of 18 January 1969). -- Germany's leading sociologist, Ralf Dahrendorf, made this plea with particular urgency for his discipline, claiming that, otherwise, the "Weltbild-Soziologie" will eat up the "Fachsoziologie" in the current process in which it is drawn into so many purposes and idelogies; he pleads even for institutional separation. (Ralf Dahrendorf, lecture "Of the Utility of Sociology", Annual Meeting of the Swiss Sociological Society, Zurich, Switzerland, 15/16 November 1968).

The bulk of basic academic research in the United States is supported by the Federal Government whose inability to formulate goals and priorities[1] encourages the university to continue its rather amorphous policies in this area. A high-ranking government official, concerned with these problems, recently admitted in an international meeting that the pseudo-rationale of American science policy -- "continuous growth of basic academic research is necessary as long as a necessity for the continuous growth of higher education is recognized, because the latter inherently depends on the former" -- has been picked because the necessity for the growth of higher education was found to be the only one not doubted in the political environment. It is time to stop this superficial and dangerous nonsense and to start looking closely at the real relationships between education and research in the university. If the relevance of research to the university's education function is made the overriding principle, a different pattern than the one resulting from the usual pressure-group game will result. To a considerable extent, basic research will ultimately be guided through its relevance for research in technological and socio-technological systems.

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[1] Harrison Brown emphasized this inability and its consequences in a TV debate on "The University and the Federal Government", recorded in Dallas, Texas, in December 1968.

A special role will be assigned to the development of the system sciences which form some kind of "meta-language" for dealing with system research in many different areas. Concepts of technical system engineering will have to be broadened to become applicable to social system engineering. This development will become of particular importance for making research more relevant for the education function. It would tend to foster an active and dynamic view of the task of dealing with the "joint systems" of society and technology, as distinct from the static view taken by system analysis. Or, as Michel Crozier[1] puts it more poetically, "as soon as the trend for rationality has enough momentum, rationalizers and systems analysts will lose ground and give way to a new kind of hero -- the creative discoverer -- who will be able to discover new problems and to define them for the rational analyst." Future education ought to focus increasingly on developing this creative capacity in students.

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[1] Michel Crozier, A New Rationale for American Business, Daedalus, Vol. 98, No. 1, general theme "Perspectives on Business", Winter 1969.

Summarizing the pressures for change in the research function of the university, we may group them in the following way:

1. Research will acquire new dimensions, particularly in the organization of scientific and technological knowledge for the purpose of engineering "joint systems" of society and technology. This type of research will provide a new and unique opportunity for developing intimate bonds between the education and the research functions of the university.
2. Coupling system research to research along the lines of scientific and technological disciplines will, to a certain extent, provide a rationale for guiding the latter and making it more revelant for education.
3. With multi-disciplinary system research -- for the purpose of engineering both complex technical systems and socio-technological systems -- tending to separate itself from the education function, research and educational structures have to be designed so as to match. In particular, this implies the abolition of the department structure oriented toward technological disciplines, and its replacement by output- and outcome-oriented structures; for socio-technological system research this ought to lead to the restructuring of the engineering schools in terms of broad social need categories.

4. Technology-oriented university research ought to focus on software and system research as well as on the earlier phases of technological innovation, avoiding industrial-type activities such as hardware and prototype development and testing.

5. The academic status and reward system, currently oriented toward scientific and technological disciplines, ought to embrace and even emphasize system research. In particular, academic careers ought to be provided in the fields of socio-technological system research.

By comparing the pressures for change, discussed for the education and the research functions of the university, it already becomes evident that they converge upon a new type of university. These pressures, acting in a disruptive way on the current type of university, can be purposefully organized so as to restructure the present university system in a way which will take them into account simultaneously.

I.4. The Service Function

In a certain way, the service function is the key to the reformulation of the purpose of the university. The passive way in which the university accepted and performed service roles in the past decades contributed perhaps most to the blurring of the purpose of the university. Again, however, it is becoming clear that disruptive forces, which have their origin in the service function, may become cohesive forces and strengthen the unification of the education, research, and service functions in a newly structured university.

Both important types of service given by the university to the surrounding community, or society at large, represent a passive type of response and contribute to enforce linearity and rigidity in our social and socio-technological structures: (1) The university educates rapidly increasing numbers of people for the professions, as defined today, in particular for the processing and the organizing activities of society, and primarily for industry and government. And (2) the university offers its specialized knowledge and skill to perform research and development services for industry and -- in the United States much more prominently than elsewhere -- for government, especially for the Federal Government.

The university turns out specialists needed for the short-term policies of these other institutions, and thereby contributes to their rigidity; but the self-renewal of these institutions will depend on the capability for self-renewal of the professionals. Through research, the university contributes to the powerful linear trends which lead to distortions in the aims and the functioning of society, such as defense and space efforts. These efforts tie in with legitimate needs and ambitions of society, no doubt, but by supporting them so massively, the university, itself, becomes subject to a distortion of its aims and capabilities. It performs "to specification" and restricts itself to the organizing of the inputs to society, which it is asked for, without concerning itself very much with the outcomes. The university, so far, does not engage in normative thinking. It leaves this to its customers. One may say, the university enjoys being a mercenary.

No wonder, that the service function of the university, as performed today, sparked off most of the dissent on the campus, apart from the student draft.

The passive way, in which the university became involved in these types of service, also led to two phenomena, or movements among faculty and students, which may soon become of serious concern: (1) A kind of despair in the university as an institution is producing short-circuited reactions among faculty and students, favouring the formation of "pressure groups" of scientists determined to fight for their view of the uses which ought to be made of science, as individuals and in groups rather -- which will make them eventually turn against the university in a much more total way than today. And (2) a "backlash" against university engagement in service to government is becoming visible. If it takes the form of demanding that acceptance of government funds be restricted to "clean" money distributed by broad instrumental agencies such as the National Science Foundation, and the National Institutes of Health which are characterized by their inability to formulate priorities and goals, it may soon become a general aversion to all contacts with government. Both movements can only contribute to the isolation of the university within society, and to its ultimate destruction.

The university has always played a decisive role in changing the structures of society. It did so, however, not by formulating its aims in terms of social objectives, but by exchanging with society the fruits of science and technology against a generous endowment. Where clear objectives were given, such as in government contract research, they were generally of a technological nature. Universities developed into pragmatic institutions, with a view to satisfying the needs of the state and of industry. In present circumstances, the university essentially does not participate in leading society into the future, in other words, in planning for society.

This leadership is now demanded of the university. The reformulation of science and technology in the light of the system sciences, as applied in particular to the "joint systems" of society and technology, is now emerging as the dominant task of the academic community.

The difference between the focus of study for the "old" and the future university -- which, of course, ought also to become the focus of its service function -- may be illustrated in the words of M.I.T.'s Provost. Traditionally, scientific and technological disciplines provided this focus: "Science is the quest for more or less abstract knowledge, whereas technology is the application of organized knowledge to help solve problems in our society,"[1] It was precisely this problem-solving capacity of the university, and, in particular, the modern institute of technology which turned it into a pragmatic institution and encouraged the utilization of its intellectual resources for piecemeal purposes.

The new focus, as already outlined in the preceding section on the research function of the university, will not be problem-solving, but the invention, planning, and design of social, and particularly socio-technological systems. "A new discipline -- which I shall call social engineering -- should be created to establish a scientifically based capability for the design and management of the various aspects of our evolving society ... The purpose .... is to provide the information for more <u>rational</u> decision making, particularly in planning activities, and to provide continuous feedback on the status of ongoing activities, so that they can be adjusted, if necessary, as they proceed. These arrangements should also provide an early-warning function, detecting unanticipated developments at an early stage. Most important and, no doubt, most difficult, they must also include procedures for taking into account moral and spiritual values and must afford adequate means of judging the human

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1 Jerome B. Wiesner, as quoted in Aurelio Peccei, The Chasm Ahead, Macmillan, New York, 1969.

qualities of the environments under consideration .... Research groups in universities, in independent study centers and in governmental agencies should be encouraged to study these problems with the same intensity devoted to investigating the physical and life sciences."[1]

In other words, integrative planning, in particular applied to the "joint systems" of society and technology, is emerging as the great new challenge for the university to restructure its service function -- and, in consequence, its self. This is not just a new mode of providing service. Integrative planning is inherently service to society. It cannot be developed without close contact with society and without the purpose to perform it <u>for</u> society.

Recognition of this shift of emphasis from hardware technology to "social software" leads Daniel Bell[2] to expect a predominant role of the university in the "post-industrial" society: "Perhaps it is not too much to say that if the business firm was the key institution of the past hundred years, because of its role in organizing production for the mass creation of products, the university will become

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[1] Jerome B. Wiesner, The Decent Society: Science and Technology, <u>Playboy</u>, January 1969.

[2] Daniel Bell, Notes on the Post-Industrial Society, <u>The Public Interest</u>, No. 6, Winter 1967.

the central institution of the next hundred years because of its role as the new source of innovation and knowledge .... To say that the major institutions of the new society will be intellectual is to say that production and business decisions will be subordinated to, or will derive from, other forces in society; that the crucial decisions regarding the growth of the economy and its balance will come from government, but they will be based on the government's sponsorship of research and development, of cost-effectiveness and cost-benefit analysis; that the making of decisions, because of the intricately linked nature of their consequences, will have an increasingly technical character. The husbanding of talent and the spread of educational and intellectual institutions will become a prime concern for the society; not only the best talents, but eventually the entire complex of social prestige and social status will be rooted in the intellectual and scientific communities."

The emerging planning function of the university is little affected if one takes a more balanced view of a basic interaction between government, industry, and the university.[1] But it does make a big difference for the education function, because the

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[1] See, for example: Erich Jantsch, Technological Forecasting for Planning and Institutional Implications, Proceedings of the Symposium on National R&D for the 1970's, National Security Industrial Association, Washington, D. C., 1967.

university will then also have to take a very active role in deciding which type of education to give to people who will later enter industry.

If we assume that both the university and industry will "reach up" to deal not with components, but with entire systems at the level of society, one may wonder in what way they will ultimately differ. However, it seems that the criteria to be applied to the future service function of the university, are not difficult to come by. For service in form of research one may hold with Robert Hutchins[1] that "the kind of research that in my view is most appropriate to a university would not in most universities be called research at all. If research is thinking about important problems, then it seems to me an indispensable part of the work of a university. If research does not involve thinking, as I believe a great deal that is called research does not, then it has no place in a university."

The crucial point is that planning has to cope with the evolutionary process of integration toward higher forms of organization in society. The horizontal integration, leading to a concern about

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1 Robert Hutchins, The University of Utopia, The University of Chicago Press, Chicago, 1964.

"joint systems" of society and technology, has become apparent from the discussion of the research function of the university.

But these systems cannot be dealt with effectively, if the vertical integration of objectives, which links the different strata of society and the pursuit of their individual objectives to each other in what clearly constitutes a hierarchical structure of ideas and objectives, reach from the individual all the way up to the global society. Institutions such as the university and industry occupy positions somewhat below the top -- permitting them to pursue, to a certain extent, their own objectives, and to interact directly with other institutions or individuals. Government at all jurisdictional levels, as representatives of society within certain system boundaries, is responsible for the pursuit of society's objectives.

However, government has neither the intellectual nor the creative capacity -- nor would we really want it to have these capacities and wield all-embracing power on their basis -- to analyze the "joint systems" of society and technology in all of their complexity, not to speak of the capability to invent, plan, and design them all alone. Without the <u>active</u> participation of those institutions which best understand how to organize creative energies, namely industry and the university, our future will be lost.

One may view the possible interaction between future institutions within society in a certain analogy to the ways in which an alert, future-oriented industrial corporation works today. The basic principle is that of decentralized initiative and centralized synthesis and control. If top management (which would be seen in analogy to the future government at all jurisdictional levels) attempts to formulate corporate policies and corporate objectives, and translate them into possible contributions from the creative people in the corporation, strategic corporate services (seen here in analogy to the university) which comprise strategic forecasting and planning as well as corporate level research and exploratory development, with emphasis on the basic end of the research spectrum, engage in the formulation and assessment of alternative strategic options. The operating divisions (seen here in analogy to industry) present, however, those strategies which they can best perform on the basis of their capabilities.

Thus, both industry and the university may be assumed to participate in the integrative planning for the "joint systems" of society and technology. But the university will take the broader look, and will serve society as an "honest broker" in assessing alternative ideas and plans as well as in promoting experiments and entirely new strategic options.

There can be no doubt, that government at all jurisdictional levels will need such an "honest broker" to counter the effects of vested interests -- because not only the university, but also industry will reach up to the level of ultimate power over society, a power which has to be utilized in a controlled way. But industry will also need broad background plans on which it can agree and to which it can orient its strategies with which it will then compete.

Perhaps the best forerunner of such a service activity of the university is M.I.T.'s "Project Transport" for a high-speed ground transportation system for the American Northeast Corridor, which essentially focussed on technical and partly also integrative, as well as R&D program planning in an imaginative way, emphasizing the assessment of alternatives.[1] Hardware development played a lesser role, and was mainly entrusted by the Federal Government to industry.

Planning by the university will also reach beyond the boundaries of planning that can be expected to be performed by other institutions, for example, in the following ways:

-- Plans are frequently worked out only when the pressure for decisions makes itself felt strongly. The lack of time to work out comprehensive and alternative plans, usually leads to a serious deterioration of the planning function and to the presentation of a single plan, patched together and with uncertain consequences. By systematically concerning itself with the long-range future, the university could recognize upcoming "decision points" in advance, and make an effort to properly determine the boundaries

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1 It is significant to note that M.I.T.'s interdepartmental task force pioneered integrative planning in the framework of this project before it was subsequently pursued on a broader national basis.

and elements of the system to deal with and to initiate its own planning in the area. Thereby, the other institutions, industry and government, may also become alert in time for their share in planning and action.

-- The most important problems even of the relatively near future will arise from distrubances at global scale.[1] To deal with them, will certainly be the responsibility of governments, but it will need the initiative and the combined creative efforts of the universities of many countries to come to grips with this challenge to integrative planning.

-- Many tasks of integrative planning will transgress jurisdictional and other structurally determined boundaries in such a way that they are less amenable to be dealt with by other institutions than the university which is little affected by such artificial boundaries.

On the other hand, it might appear that the current pressure on the American university to assume also management functions, e.g., for surrounding poor or disorganized communities, is wrongly aimed. The university should take an active interest in the surrounding community by planning for it in an imaginative and possibly continuous

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[1] Aurelio Peccei, The Chasm Ahead, Macmillan, New York, 1969; and R. Buckminster Fuller, Operating Manual for Spaceship Earth, University of Southern Illinois Press, Carbondale, Ill., 1969.

way, but it should do so in order to enhance the management capabilities within the community itself.

If industry does not deteriorate to becoming a place for mass production, it will need the university more than ever to provide it with scientifically and technically trained talent as well as with "social system engineers". But to provide service to industry in the form of education will require the types of changes in the education function, outlined in the corresponding section above. Above all, the change in the method of learning from training to purposeful work will become a prerequisite. Not only will this become necessary to enhance the students' ability to become, again in Michel Crozier's words, "creative discoverers" of new structures and functions of social systems, but also it is the compassion and enthusiasm of the young people which will have to carry much of the university's future integrative planning services for society. "Students everywhere share a visceral, intuitive conviction that society is sick and that they are getting little guidance on how to cure it. Many young faculty members share this feeling. Every campus has its quota of activist and dissident students and faculty members. They should be encouraged to seek out ways of understanding and counteracting the social deficiencies to which they are reacting, because they have zeroed in on very real problems that require far more serious attention than they have been given. The challenge for us in the universities -- be we humanists, scientists or technologists -- is to engage the creative energies of the dissidents in joint efforts on communal problems, so that they can find the socially useful careers they seek."[1]

Both this type of student education through purposeful work and the increasing role of life-long education[2] may be accommodated in a new type of system laboratory within the university, which will be briefly described in Chapter II. Again, structural changes in the university may be brought about by the pressures emanating from these developments in our evolving society.

Summarizing the pressures for change in the service function of the university, the following points may be made:

1. The university ought to engage itself _actively_ in the evolutionary process of society. It ought to become a _political institution_ in the broadest meaning of the term. In this task, which is essentially that of organizing scientific and technological knowledge, it will interact with industry and with government in an integral approach.

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[1] Jerome B. Wiesner, The Decent Society: Science and Technology, _Playboy_, January 1969.

[2] It is significant that M.I.T.'s Center for Advanced Engineering Study already focusses on education geared to the planning and engineering of systems, although in general not yet socio-technological systems.

2. The service function of the university ought to emphasize research based on thinking. In particular, the university ought to assume an active role in the integrative planning of the "joint systems" of society and technology, inventing, planning and designing alternative systems and participating in a wide competition between ideas and plans.

3. Service given by the university ought to be conceived and performed with a special view to long-range outcomes.

4. Service in form of education of students and of life-long education ought to be geared to bring out individual creativity and the capability for continuous individual self-renewal.

I.5. The New Purpose of the University

A synopsis of the pressures for change, as recognized and discussed in the preceding sections of this chapter, for the individual functions of the university -- education, research, and service -- and those for change in society at large, yields a picture of powerful forces which act disruptive within the existing structures, but seem to converge reasonably well in their ultimate meanings and implications. The new purpose of the university may readily be found in this area of convergence of reason. It may be expressed as the new purpose of the institution itself, not of its members.

In most general terms, the purpose of the university may be seen in the decisive role it plays in enhancing society's capability for continuous self-renewal. It may be broken down further in line with the principal characteristics of a society having this capability, as spelled out by John Gardner:[1]

-- Enhancing the pluralism of society, by bringing the creative energies of the scientific and technological community as well as of the young people, the students, fully into play -- not for problem-solving, but for contributing to society's self-renewal;

-- Improving internal communication among society's constituents by translating into each other the mutual implications of science and technology on the one side, and social objectives on the other, and by pointing out the long-range outcomes of alternative courses of action in the context of broadly conceived social systems;

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[1] John W. Gardner, in his Godkin Lecture, Harvard University, March 1969.

-- Providing positive leadership by working out measures of common objectives, setting priorities, and keeping hope alive, as well as by promoting experiments in society through ideas and plans, and, above all, by educating leaders for society.[1,2]

The new purpose implies that the university has to become a political institution in the broadest sense, interacting with government (at all jurisdictional levels) and industry in the planning and design of society's systems, and in particular in

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[1] The leadership function of the university was also explicitly recognized by Yale University's President Kingman Brewster (but rejected by the other eminent panelists) in the TV debate on "The Future of the University", recorded in December 1968. But, at the same time, Dr. Brewster warned that the crucial problem for the university will be the maintenance of its freedom as society becomes more highly organized and pressures for regimentation might thereby increase.

[2] M.I.T.'s President Howard W. Johnson recognizes the following basic qualities of a leader: Competence by intelligence and knowledge, coupled with a capability of creative problem-solving; character values such as dependability, responsibility, energy, and idealistic strive for the improvement of the world, not without a sense for harmonizing idealism and action; target-orientation and cleverness in the choice of strategies and means, coupled with consistency in action; and, finally, personal enthusiasm, coupled with intellectual curiosity and willingness to accept risk. (Retranslated from an editorial report on Dr. Johnson's lecture "Educational Requirements in an Industrial World," Technical University (ETH), Zurich, Switzerland, 16 January 1969, which appeared in the Neue Zürcher Zeitung, foreign edition No. 17 of 18 January 1969, under the title "Upvaluing the Humanities").

controlling the outcomes of the introduction of technology into these systems. The university must engage itself in this task as an institution, not through the members of its community.

The university ought to become society's strategic center for investigating the boundaries and elements of the recognized as well as the emerging "joint systems" of society and technology, and for working out alternative propositions for the integrative planning aiming at the healthy and stable design of such systems.

The major changes which this new purpose will bring to the university, include the following ones:

- -- Principal orientation toward socio-technological system engineering at a high level, leading to emphasis on generalization rather than specialization of education and research;
- -- Emphasis on purposeful work by the students rather than on training;
- -- Organization by outcome-oriented categories rather than by inputs of science and technology, and emphasis on long-range outcomes.

With the new purpose, the education, research, and service functions of the university will again merge and, in fact, become one. Where the old notion of "universitas" was that of comprehensive knowledge, acquired by dissecting the real world, the new notion will mean the "universitas" of the three functions of the university, as well as their integrative approach toward the systems of the world -- in particular the "joint systems" of society and technology.

This new notion of the "universitas", implying a fundamental switch toward broad, horizontal thinking across the disciplines will, as the President of Carnegie-Mellon University[1] points out, inevitably lead to a transitory crisis period for the university which has developed its excellence by penetrating deeply into sharply defined, more or less independently pursued disciplines. The critical spirit of the university which will be of paramount importance in this difficult transitory period, will also have to be applied to the preservation of the structure and contents of the body of scientific knowledge -- as distinct from its application and the guidance it receives for its further development from the purposes served by the university.

The task is much vaster than just that of organizing new types of inter-disciplinary interaction, and also vaster than just bringing together C. P. Snow's "two cultures" of the scientific-technical and the humanistic. The task is to mobilize all energies and all knowledge for a concerted effort to shape actively our future.

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[1] H. Guyford Stever, Trends of Research in Universities, in Proceedings of the Symposium on National R&D for the 1970's, National Security Industrial Association, Washington, D. C., 1967.

CHAPTER II. SOME ASPECTS OF AN "IDEAL DESIGN" OF THE NEW UNIVERSITY

II.1. The Need for Adaptive Institutions[1]

Throughout history, mankind's evolution progressed toward ever higher degrees of organizational integration. This trend may be observed from the early phases of organized hunting over the development of agriculture and the crafts on the basis of increasingly complex forms of settlement, the partition of work and trade, all the way up to the present state of industrialization and world trade.

Technology has always acted as an important agent in this process of integration. Its role is becoming particularly conspicuous in our century with developments in such areas as transportation and communication. But above a certain threshold, even disruptive technologies, such as weapons technology, tend to develop strong integrating forces, as is borne out today in the development of relations between the superpowers.

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[1] This section is adaped from: Erich Jantsch, Adaptive Institutions for Shaping the Future, in Perspectives of Planning, OECD, Paris, 1969.

As technology wields power to enforce integration, it becomes ever more important to (a) investigate and anticipate the dynamic development of socio-technological systems and their changing boundaries, and (b) influence this dynamic process actively by controlling the development of technology from a point of view of anticipated outcomes. This is the first aspect of the need to develop new institutions.

The second aspect arises from the mutual inter-dependence of planning and instituions. A specific type of planning demands, and makes possible, specific types of institutions, and vice versa. The example of central planning at the national level, as it is practised in Eastern countries, demonstrates the spectrum of institutions which are directly affected, although varying widely in their scope. Extending far beyond the institutions set up to elaborate plans, this spectrum also comprises the institutions set up to implement plans -- as a matter of fact, most of the institutions carrying out tasks in relation to the needs of society. One may go further in stating that a specific type and "spirit" of the planning process correspond to a specific structure of or within society which, in turn, finds its expression in particular types of institution.

If we assume the task of integrative planning, the design of plans and of institutions has to be seen as an integral process, not as a parallel or consecutive process. Integrative planning is inherently planning for change in complex, dynamic systems. The planning of institutions -- for planning itself, as well as for the realization of planned change, and for subsequent control -- is an important aspect of integrative planning. This means, for example, that planning for technological innovation ought to include planning for new social institutions.

If the university, as this paper holds, is to accept an important and leading role in integrative planning, its task will comprise restructuring society and its institutions -- including the university itself.

It is useful to look back for a moment at the changes in institutional concepts over the past few decades. This will help us to understand the changes which are now required, as evolutionary rather than revolutionary. We may distinguish between three basic types:

-- Instrumental institutions are primarily geared to the deployment of more or less rigid sets of material and non-material resources for innovation (or conservation) and not to the innovation process as such. They preserve linearity of planning and action, are insufficiently sighted on future objectives and outcomes and attempt systemic consistency mainly with regard to quantitative problems of resource deployment, and usually not going beyond pseudo-rational "decisionistic models" which may be considerably influenced by the interaction of pressure groups. Frequently, instrumental institutions are characterized by the absence of planning altogether. Examples in the areas of science and technology are the National Science Foundation and the National Institutes of Health, the proposed Department of Science revived now after ten years of dormancy, the European-type university, and many fundamental research set-ups within and outside the university. The broad instrumental character of the latter, especially research institutions in "big science", has encouraged the fatal linking of fundamental research to higher education, and has, thereby, enforced the application of instrumental criteria to both areas.

-- Pragmatic institutions are geared to action leading to well-defined objectives, usually accepting a medium-range look into the future (as far as the "freezing" of such objectives permit). They are not, or are little concerned with defining the objectives of such action. Pragmatic institutions may, therefore, be regarded as *ad hoc* arrangements for effective tactical (operational) planning and implementation, corresponding to a specific strategy. They become a problem when they tend to become permanent. Examples of pragmatic institutions in the area of science and technology are the modern Institute of Technology, industrial product line development and project management. Pragmatic institutions have been vehicles for the enormous acceleration of technological, and thereby social change in our time, and for our academic and industrial excellence in technological disciplines. They constitute a propitious framework for linear growth goals, not for integrative planning and socio-technological system engineering.

-- Adaptive institutions are geared to the flexible process of continuous search and modification which is the essence of planning at the strategic and policy levels. They may include, and make use of "building blocks" which are, in themselves, pragmatic in nature. Adaptive institutions, or inter-institutional structures, permit the systematic consideration of high-level objectives and alternative means to meet them. Long-range forecasting and planning over a time scale of several decades can be practised in the fullest sense only within their framework. Examples include the gradually introduced Planning-Progamming-Budgeting System of government -- once it will have achieved its full impact --, to a certain degree the National Aeronautical and Space Administration (NASA) and the use of flexible "innovation emphasis structures" in advanced-thinking industry.

It may be noted here that Herbert Marcuse's now famous "one-dimensional man" would only be free to move between the two extremes of being organized in a society with pragmatic institutions -- the "repressive" civilization enforcing the principle of individual efficiency in the service of social goals, which overshadow individual goals -- and a "non-repressive", essentially anarchist society which would dispense with institutions (except those providing the material needs of man). In this view, the one-dimensional spectrum of possibilities would range from the supremacy of society and civilization (and the "repression" of individual goals) to the supremacy of the individual (and, consequently, the "repression" of social goals and the concerns of mankind as a whole). If, at the one extreme, the synergistic effect of society and civilization is led _ad absurdum_ by lack of creative inputs, the negation of mankind's psycho-social evolution and its reduction to the sum of individual creative acts (which are seen as the expression of man's _eros_), which we find at the other extreme, leads straight into the abyss of uncontrolled development and the catastrophes which can be readily forecast -- in other words, to complete loss of human freedom.

In the present period, where we recognize the need for control of technological and social growth trends, reliance on the existing instrumental and pragmatic institutions would turn Marcuse's model into nightmarish reality -- this is the actuality which students discover in the model and become so frightened about.

Adaptive institutions, along with the integrative, normative, and adaptive character of what has been called "futures-creative" planning, provides a genuine alternative to this one-dimensional technological dilemma -- one may say, they add a second dimension of rationality to the application of human creativity and freedom. This leaves us still short of the urgently needed third dimension, wisdom, which we must strive to develop through a renewal of interest in the broad, humanistic background, and the integral living experience of man in a historical perspective.

The following sections of this chapter deal with aspects of a university structure, corresponding to the adaptive type. But it has to be emphasized that adaptive institutions, by their very nature and their concern with systems affecting society, cannot operate in isolation. The task will not only be to restructure the university, but also to set an example and the general direction of institutional reform in society at large.

II.2. The Basic Structure of the New University

To conceive of a university satisfying the demands on an adaptive institution, is perhaps less complicated a task than it would be for industry. The "vested interests" of the university, which have to be overcome, are of a "soft" type. They are embedded in specialized knowledge and skill and -- perhaps more important -- in status and award systems. The latter can be changed by structural changes; the former can be changed by providing the proper challenge to motivate part of the faculty and many of the students to break out of specialization. With some of the best students quickly moving up into faculty positions, the process -- once the difficult start has been made -- may take some ten years to achieve really basic changes.

"Adaptive", in the context of the university, means primarily the response to two aspects of self-renewal: The continuous self-renewal of the university itself, and the education for continuous self-renewal which it gives to its students. Both aspects can be brought together, with the university becoming more closely and more actively involved with society, a development which cannot be rigidly planned in advance.

The "joint systems" of society and technology, on which the university will have to focus its attention, are not rigid, and are not always clearly recognizable. New systems will come to the foreground, as growth and development trends in the world are becoming entangled in new ways, and transgress limits for stability and viability. It will be of particular importance to anticipate and detect such systems of future concern at an early stage. Ultimately, technological means for coping with the tasks of socio-technological engineering, may decrease in relative importance and become supplemented to an increasing degree by the subtler means of social technology.[1] The World Food Problem, for example, may be tackled in the presence of an ongoing population explosion by developing non-agricultural food production technologies; but the alternative would be to stop the population explosion by more powerful means of education and persuasion than are at our disposition at present.

How will the new university be able to find an institutional framework which, on the one hand, will enable it to focus on its tasks with the required precision, and will, on the other hand, resist, to a reasonable degree, the temptation to rigidify? The answer may be found in some of the criteria for the new university, as developed in Chapter I:

-- The new institutional framework will bring together, and even unify, the three functions of the university -- education, research, and service --,thereby revitalizing the university by the continuous and inherent interaction between the three aspects they represent;

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[1] The term "social technology" is used here in the meaning given to it by Olaf Helmer in his book Social Technology (Basic Books, New York, 1966). It embraces motivation, direct persuasion, and planned challenge/response interaction rather than "hard" technology.

-- The mobility of people, as well as of ideas, will be encouraged by the new design;

-- The active engagement in purposeful work by the students and by faculty, and the introduction of an integral and stimulating challenge may be expected to elicit creative response of unprecedented momentum within the university; also, active participation in change counteracts the tendency to build "empires" of knowledge and skill, which may be seen as attempts to hedge against the unforeseen consequences of dictated change;

-- Long-range thinking has a powerful effect in structuring thinking about action in the present, and consequently also institutional set-ups.

The basic structure of the new university may be conceived as being built on the interaction between three types of units, all three of which incorporate their appropriate version of the unified education/research/service function:

-- System laboratories (which, more precisely, may be called socio-technological system laboratories), emphasizing system engineering in the broad areas of "joint systems" of society and technology, and bringing together elements of the physical and the social sciences, engineering and management, the life sciences and the humanities. Their tasks will not be sharply defined, but rather broad areas will be assigned to them, such as "Ecological Systems in

Natural Environments", "Ecological Systems in Man-Made Environments", "Information and Communication Systems", "Transportation/Communication Systems", "Public Health Systems", "Systems of Urban Living", "Educational Systems", and the like. These broad areas will, and should, overlap. Apart from engineering specific systems (e.g. broadly accessible computerized information systems that protect privacy according to criteria prevalent in society), these system laboratories will also have the task of long-range integrative forecasting[1] in their areas, identifying aspects and boundaries of systems of future concern. They will be responsible for exploratory and experimental system building at smaller scale, and they will provide opportunities for a through-flow of professionals for their self-renewal. The organization of these system laboratories, which represent a new concept in the university, will be briefly discussed in the following section II.3.

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[1] Integrative forecasting, in analogy to integrative planning, denotes forecasting cutting through many dimensions, such as economic, social, political, technological, psychological, anthropological dimensions. See, for example: Frank P. Davidson, Macro-Engineering -- a Capability in Search of a Methodology, <u>Futures</u>, Vol. I, No. 2, Guildford, Surrey, December 1968.

-- Function-oriented departments(which might also be called "mission-oriented departments", if this term would not suggest a pragmatic and ad-hoc set-up), taking an outcome-oriented look at the functions technology performs vis-à-vis society, and dealing flexibly with a variance of specific technologies which all might contribute to the same function. Examples of such functions are "Housing", "Urban Transportation", "Power Generation", "Automation and Process Control", "Educational Technology", "Telecommunication", "Food Production", etc. These functions are more clearly defined, and constitute more stable "modules" than the socio-technological systems of which they are facets. They constitute need categories which elicit the response of different technological options. Thinking in these categories implies breaking out of the linearity of specific technological development lines, and keeping the view open into a longer-range future. Education in the framework of these technological functions vis-à-vis society will become ever more relevant, with industry increasingly adopting a corresponding organizational framework.[1] Apart from developing techno-

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[1] Erich Jantsch, Integrating Forecasting and Planning Through a Function-Oriented Approach, in James R. Bright (ed.), Technological Forecasting for Industry and Government, Prentice-Hall, Englewood Cliffs, N. J., 1968.

logical options, which come under the heading of these functions, these departments will also emphasize system analysis of the effects and side-effects of selecting specific technologies for satisfying needs in these areas, forecasting which will be more properly technological forecasting in its broad connotation, and assessment of the "system-effectiveness" of technologies in the context of social systems. The organization of such function-oriented departments will be briefly discussed in section II.4. below.

-- <u>Discipline-oriented departments</u> of a familiar type in the university today but comparatively smaller and more sharply focussed on this discipline. These departments would be mainly set up in the basic scientific disciplines, of the physical as well as the life and the social sciences -- perhaps even for management --, but not for technological disciplines as they dominate today. There will, for example, be no Department of Electrical Engineering, but possibly a Department of Computer Science.

It is quite possible that some broad Policy Planning Center will have to supplement this three-level structure, mainly for the guidance, balance and maintenance of flexibility of the system laboratories.

But it will be essential that the structural units at all three levels form integral parts of the university as an institution. It is their close interaction which will be essential for all three functions of the new university. Conceiving for example, the system laboratories as "buffer institutions" which were somehow attached to the university, would stifle this interaction and lead to a deterioration of all three functions.

The three levels of institutional structure correspond roughly to the three interacting levels of full-scale long-range planning: Policies, strategies, tactics. They are essential for the role in integrative planning which we may foresee for the new university. Unlike present university structures, focussing to an excessive degree on "know-how", the function-oriented departments will emphasize "know-what" -- the quality which Norbert Wiener put before "know-how" -- and the system laboratories "know-where-to", which both are prerequisites for our ambitions to actively shape our future. The discipline-oriented departments on their side will make a new and conscious approach to "know-why" rather than "know-how."

The interaction between the three types of structural units, as summarized in Table I, is best discussed under the headings of the three functions of the university, namely education, research, and service:

In the education function we may see a basic split into education for scientists, education for stationary engineers, geared to functions of technology rather than to classical engineering skills or specific

	Education	Research	Service
System Laboratories	Socio-technological system engineers	Integrative planning and design for "joint "systems" of society and technology	"Know-where-to" through inventive contributions to public policy planning and to the active development of new socio-technological structures
Function-Oriented Departments	Stationary engineers (oriented toward functions and mission for technology, not toward engineering skills or specific technologies)	Strategic planning and development of alternatives (including innovative technological research) in areas defined by functions of technology in a socio-technological system context	"Know-what" through providing strategic impulses to the development and introduction of technology into systems of society
Discipline-Oriented Departments	Specialist-scientists	Research at the fundamental level, and development of theory	"Know-why" through clarification of the logic principles inherent in scientific disciplines

Table I. The Pattern of Focal Activities in the New University. The higher-level activities in this scheme are always carried out by interaction with the lower-placed activities in the vertical columns. All activities are horizontally integrated over the university functions of education, research, and service.

technologies, and education for socio-technological systems engineers (or enterprise engineers, as Forrester[1] calls the latter). Whereas the stationary engineer will be much more broadly oriented toward the application of technology in the context of social systems, the socio-technical systems engineer, in Forrester's words[2], "must be a leader, a designer, and a synthesizer. He is a doer. He understands theory as a guide to practice. He must concern himself with human organization because the pace and success of technology are becoming more dependent on interaction with the social system and less on scientific discovery ..... (These men) will strengthen the information links between physical design and the public so that technology can better serve society. In the public sector they must show that level of wisdom and leadership that can coordinate great engineering projects with politics."

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[1] Jay W. Forrester, Common Foundations Underlying Engineering and Management, IEEE Spectrum, September 1964.

[2] Jay W. Forrester, Engineering Education and Engineering Practice in the Year 2000, paper presented to the National Academy of Engineering, 21 September 1967, at the University of Michigan; to be published by the Academy.

Whereas Forrester believes that the number of such socio-technical systems engineers needed will be relatively small, "perhaps one for every fifty of today's ordinary engineers", one may believe that it will quickly rise with the variety of such system engineering to be tackled. Possibly not all universities will provide both types of education -- those which do, and which will be the leading universities, will probably have to educate up to one-third or half of the students along this line.

We may then envisage a university in which some students go through discipline- and function-oriented departments only, and others go through all three types of structural units. As the latter proceed from undergraduate to graduate and doctoral work, they will shift the emphasis of their studies from discipline- and function-oriented departments more and more to the system laboratories, at the same time getting increasingly involved with purposeful work in technology and actual socio-technological system engineering, which will become a full-time engagement during the doctoral work. Work phases and "absorptive" phases may alternate, with the need for theoretical learning being enhanced and guided by work. A future socio-technical system engineer will probably work in a system laboratory already as undergraduate, whereas a stationary engineer will gravitate to the function-oriented departments (and get also a system-emphasizing education there, which will permit him to see his professional role much better). But, in essence, students will not go through these structural types in sequence, but interact with them simultaneously during their studies. As Forrester[1] remarks, "men mature to various subjects in different sequences. Some students see first the challenge of design. They then turn to science to acquire a necessary foundation".

Such a university will turn out people with a widely varying education, from specialist-scientists over mission- and function-oriented scientists and engineers to full-scale socio-technological system engineers.

Letting both educational avenues for engineers run together, ending with a degree certifying the proficiency in disciplines and functional "clusters" of technology, and adding for those who want to stay on, three more years in the system laboratories, would not be feasible. Not only would the engineer then leave school really past his creative prime in many cases, he would also find it difficult to switch so late in his education to an entirely new outlook, and to respond to a quite different kind of challenge.

The system laboratories will also be the preferred level for the through-flow of professionals who will probably come back to the

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1 Jay W. Forrester, Engineering Education and Engineering Practice in the Year 2000, paper presented to the National Academy of Engineering, 21 September 1967, at the University of Michigan; to be published by the Academy.

university in much greater numbers than today for their continuous education. The loose structure of these laboratories, which will be briefly sketched in section II.3. below, will make it possible for the professionals, faculty, and students to work jointly on system engineering projects.

One may believe that the outlined three-level structure will give the education function greatly increased flexibility in many respects -- for specialized as well as broad (but not superficial) education, for changing tracks, for participating in various actual projects and in various qualities, for combining student and adult education, for stimulating leadership and professionalism, for education geared to various types of careers in the public and private sectors.

An important aspect concerns new dimensions in learning which may be opened up by the change from receiving training to doing useful work. With the university structure outlined here, education will take on more and more the form of self-education, and only part of it with the help of "teachers". The future availability of computers for educational purposes, not in the present form of pre-programmed questions and answers, but in the form of multiple-access time-sharing systems in which students may search and "playfully" explore stored knowledge and interrelationships from actual and purposeful work, will greatly enhance this self-education -- much beyond the most effective educational method of today, browsing through books. It will not only enhance the student's independence, but encourage him to explore further than he would ever dare with his teacher, because with the computer he can afford to be caught "stupid" and his inquisitive mind may induce him to go on for hours and days in a frenzy of exploration.

A student working in a system laboratory will be able to judge for himself what working and learning experience he needs from the function- and discipline-oriented departments, to which he will go back part of his time. He will be able, to a relatively large extent, to work out his curriculum himself, and to set his own educational goals and priorities. Education will move away from the stereotypes of today and become increasingly self-education in an environment which provides an infinite variety of possibilities.

This will be possible, because the student's work can be judged directly from his contribution to useful work. He may, therefore, graduate and obtain higher degrees without being examined by the rigours characteristic of the university today. No grading system will be necessary to measure the development of his capabilities. He may not even write a thesis by himself, but make corresponding contributions to team work.

In the <u>research function</u>, the interaction of the three types of structural units will again be "led" by the system laboratories. They will give spur and focus to technological and also to basic scientific research. The Vice President in charge of basic research at the Bell Telephone Laboratories[1], truly a system-oriented research place, recognizes this explicitly: "The greatest technical innovation of the future will involve whole systems of transportation, construction, public health, agriculture, defense, communications, etc. The basic scientific factors that underlie the elements of the system will become ever more important .... Basic science will lead us to new realms of innovations in which the life sciences, the physical sciences and the behavioral sciences will be combined in new ways of learning and in new forms of society. The time has come, with the aid of simulation and the statistical capabilities of the digital computer, to seek many more common languages and common concepts for the joint systems of man and Nature."

The basic form of interaction between the three types of structural units will be a translation process in both directions between the dynamic characteristics of socio-technological systems, functions and missions for technology, and contributions to them from the scientific disciplines. But the most important task in this process will be the formulation of socio-technological system engineering requirements in terms of technological missions and "building blocks." This task will fall primarily to the system laboratories.

The enhanced "know-what" will not strangle the freedom of research, but, on the contrary, will give it deeper meaning. This will also

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[1] William O. Baker, "Broad Base of Science", in series Innovation: The Force Behind Man's March into the Future, The New York Times, 8 January 1968.

reflect in the support of research at all levels by the public, as William Carey[1] observes: "... if public policies are to be durable and survive the rigors of changing times, they must grow out of deeply held beliefs and values of the society, rather than from its transient impulses. So with public policy toward science. If it is to be strong, it must first be relevant and it must be shown to have relevance. If research and development are necessary prerequisites of acceptable national security, or of better health care, or of efficient transportation, or of safer airways, or of getting the mail delivered, or of the control of crime and violence, or of the enrichment of education and learning, and if these are the central concerns of our society, then science and its advocates must learn to shape research and development accordingly and give it relevance in these terms." This plea for relevance is far from the pursuit of a utilitarian concept. It touches on the purposes of our life and our striving toward knowledge and learning.

The separation between function-oriented departments and discipline-oriented departments will provide the type of institutional separation required to satisfy the need for keeping theory and

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[1] William D. Carey, Toward the Proper Study of Man, Technology Review, March, 1969.

application sufficiently apart from each other in the process of broad engagement in the service of society.

On the other hand, basic research will experience considerable bounce when the long-range oriented planning activities of the system laboratories and the function-oriented departments will pose questions pertaining to absolute potentials and limitations.[1]

For the service function, the system laboratories may well assume the role of "prime contractors" which will sub-contract work to the function- and discipline-oriented departments, including support of basic research. The university will have to establish a certain balance in funding, because it will primarily, or even exclusively, be the system laboratories to negotiate funding for university projects involving the interaction of all three types of structural units.

What this leadership of the system laboratory in the service function really amounts to, is the active role of the university in national (and, later perhaps in international) science policy: "If our policies and strategies for science and technology are hard to fathom, perhaps it is because we are not well organized. Research and development are decentralized through the Federal Government, managed as a

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[1] A similar bounce for basic research may already be observed in a number of long-range oriented industries.

network held together loosely by the White House science office," writes William Carey[1], the former Assistant Director of the Bureau of the Budget. "There is no prime mover; the decision-making patterns are pluralistic. As an institutional process science and technology are not responsive to standards of balance, purpose, or priorities. The component elements serve as mission-related conduits for funding research, development, training, and academic science; they do not function as a system because there was not a system to begin with."

The interaction between the three structural levels of the new university may, for the first time, lead to the investigation and active shaping of such science policy systems, and to their implementation through the university. This is what has been called in this paper the role of the university as a political institution. The full impact of the new rationale will be reached when governmental science policy will adapt the funding structures which the university will propose, or even demand.

It may be noted at the side, that the outlined structure of the university and its unified education, research, and service functions, will make it the ideal place to apply the planning and management framework of the Planning-Programming-Budgeting System (PPBS), which, so far, functions less well in government, precisely because government cannot bring itself to adopt appropriate structures.

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[1] William D. Carey, Toward the Proper Study of Man, Technology Review, March 1969.

Some aspects of the service function, concerning the university's institutional ties with society, will be briefly discussed in section II.6. below.

Providing academic careers for all three types of structural units will give immense freedom to the entrepreneurs, and may also change the traditional status system of the university. As a matter of fact, the university professor, as we know him today, may almost vanish, or become almost indistinguishable from the students and professionals, at least in the system laboratories and, to some extent, in the function-oriented departments. What we call faculty today, may be the entrepreneurial leaders of the system laboratories tomorrow, and the through-flow of younger and older people would be identified today as students moving on in their studies, and professionals moving in and out of the university in their almost continuous education. This theme will be developed a little further in the following section on the organization of system laboratories.

However, an important problem ought to be touched here briefly in a more general way: With the increased flexibility of university structures, especially in the system laboratories, loyalty to the university will become even a bigger problem than it is today. Also, with the type of "profit-center" operation which might be established in the system laboratories, the possibilities to interact with different laboratories at the same time, within and outside the institution, will increase greatly. This paper does not propose any solution to the problems that may arise from this added flexibility, and from the needs of the education function that run somewhat counter to them.

Finally, an aspect of particular concern to students may be pointed out: remuneration for purposeful work. With the education, research, and service functions practically falling together, the current standard formula -- students maintain themselves in the later semesters by means of assistant- or fellowships, and all types of grants, but contribute to research and service without remuneration -- may be exchanged for a much healthier one: Who does useful work, should be remunerated to the extent of the quantity and quality of his contribution. Essentially, this implies a shift in the rationale of student funding, not so much the necessity to open up new sources for funding.

II.3. The Organization of System Laboratories for Integrative Planning and Design

System laboratories, as they are proposed here as one structural level of the university, have been described in an important paper by Jay Forrester,[1] which has perhaps not yet found the attention it merits.

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[1] Jay W. Forrester, Engineering Education and Engineering Practice in the Year 2000, paper presented to the National Academy of Engineering, 21 September 1967, at the University of Michigan; to be published by the Academy.

Only the time-frame may be misleading -- not in the year 2000, but in the 1970's will the university be faced with an urgent need for their development.

However, where Forrester believes in the necessity to set up a new type of institution, alongside the old institution of the present-type, this paper advances the argument that the creation of system laboratories for integrative system design as part of the university will make it possible to restructure the entire university. Thus, the new university may become that new type of institution -- certainly the most desirable solution -- or, at least, some of the existing universities and, above all, institutes of technology, may transform themselves accordingly.

The system laboratories will be geared to the development of "a new kind of leadership indicating distant goals of such large significance that they dominate the trivial trends toward expansion for expansion's sake"[1]. Their primary role is that of pacemakers, and their work ought to be openly published, no matter with whom it is contracted.[2] If planning is to be more than the enrichment of

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[1] René Dubos, Scientists Alone Can't Do the Job, Saturday Review, 2 December 1967.

[2] In this connection, it is of interest to note that the newly created "Institute for the Future" in Middletown, Connecticut, which ultimately is supposed to develop into a system laboratory of the type described here, accepts no contract which restricts publication in any way, except for proprietary direct information furnished by the client.

the information basis for decision-making, it has to include some measure of motivation for people who will be affected by the plans. This motivation should not be generated by bias or by presenting plans without alternatives, but by explaining the methods of work and the long-range consequences of alternative courses of action assessed by these methods.

"Good planning," states Jay W. Forrester[1], "based on a deep insight into the behavior of complex systems will attempt to release the internal power, initiative, driving force, enthusiasm, and human potential of the people in the system. It will do this instead of heaping more work, more discipline, more repression, and more coordination on them in an effort to push back a social system that is still trying to go in the wrong direction."

The system laboratories will not simply focus on pointing out present and future problems of concern and means for remedy, as is usually demanded today from scientists. They will not only try to bolt wrong courses of action, for example by recommending "technological fixes" (Alvin Weinberg). In some situations such fixes may be useful for the short-range end of strategies, arresting

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[1] Jay W. Forrester, Planning Under the Dynamic Influence of Complex Social Systems, in Perspectives of Planning, O.E.C.D., Paris, 1969.

bad trends. But for the longer range such an approach would only lead to endless "technology/counter-technology chains" (René Dubos).

The central task of the system laboratories is not one of analysis, but one of design. In Jay Forrester's[1] words, "planning can have a different structural, if not temporal, relationship from ordinary decision making when we examine how planning might be related to social systems. Planning, instead of dealing with problems and their solutions, could deal with the design of social systems to produce systems less likely to generate problems. Planning, if addressed to the design of social systems, would ask not how to fix the present difficulties, but instead what leads the system into undesirable conditions. With the structure and cause of problems identified, one can then move to avoid such problems rather than to encounter them repeatedly and attempt to alleviate them..... Removing causes may take quite different actions from those aimed at alleviating symptoms. The cost of removing causes is often far less. The influence is much deeper. The improvements last longer."

The forecasting of the systemic consequences of alternative system designs will be a powerful means to plan policies in a more

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1 Jay W. Forrester, Planning Under the Dynamic Influences of Complex Social Systems, in Perspectives of Planning, O.E.C.D., Paris, 1969.

rational way.[1] It also permits identification of elements and relationships within the system which ought to be changed, and thereby permits the translation of dynamic system objectives into missions for technology as well as the setting up of criteria for "system effectiveness" of alternative technologies. This is the "guiding" role of the system laboratories for the function-oriented and discipline-oriented departments.

It is quite evident that every bit of the work done in the system laboratories is integrative in the sense that it deals with many facets of social systems, of which technology is but one. The methodology for dealing with the dynamic behavior and the design of complex social systems is largely not yet available nor tested for application to such systems. However, a number of valid basic approaches are known, one of which is "Industrial Dynamics", which, today might better be called "Social Dynamics". Further development of methodology might perhaps be monitored and actively pursued in small joint set-ups between the system laboratories of a university, which, of course, will have to interact very closely with the laboratories. Such methodological centers of a number of universities may also form the back-up organization to interact with developments in

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[1] The consequences of alternative policies, in terms of growth, stagnation, and decay of the city is studied in: Jay W. Forrester, Urban Dynamics, The M.I.T. Press, Cambridge, Massachusetts, 1969.

other advanced countries in the framework of the proposed "International Institute for System Methodology", should it materialize.[1]

A fully-developed structure of system laboratories within a university may consist of perhaps ten to twenty laboratories with different focal themes, which may -- or even ought to -- overlap to some extent. It would certainly be the wrong approach to try to have a all imaginable focal themes represented in each university. "Centers of excellence" may be envisaged to develop in an organic way, building on available skills and interests which may gravitate naturally toward a number of focal themes.

The system laboratories of a university ought to have a "forum" where they could meet and discuss their approaches in a semi-formal way. Such a "forum" may well be administered by the staff of the joint methodological center, proposed above. If such a center takes, as indeed it ought to, a very active attitude, it may also, to some degree, insure the flexibility of the system laboratory network, and become instrumental in the adoption of new focal themes as well as in closing down laboratories or shifting their emphasis.

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[1] Preliminary talks which may lead to the creation of such an institute, are under way between the United States, the USSR, and a number of Western European countries.

Most, or all, of the system laboratories will build on knowledge derived from the physical and life sciences as well as the social sciences, and from engineering in general. Such a broad interdisciplinary basis for team work has rarely been established so far. But the approach in the envisaged system laboratories will go far beyond team work between specialists -- the interdisciplinary nature of the work will be represented in each participant.

It may be foreseen that many universities will have to adapt, or add to, their present structure of disciplines. This will probably hold in particular for the life and behavioral sciences. If there is a unifying "super-theme", tying the various system laboratories together and compounding their outputs, it can only be what René Dubos[1] calls the "science of humanity", the science of man's total living experience: "Since human beings are as much the product of their total environment as of their genetic endowment, it is theoretically possible to improve the lot of man on earth by manipulating the environmental factors that shape his nature and condition his destiny. In the modern world, urbanization and technology are certainly among the most important of these factors and for this reason it is deplorable that so little is done to study their effects on human life..... .... Scientific knowledge of the effects that surroundings, events

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[1] René Dubos, So Human an Animal, Scribner, New York, 1968.

and ways of life exert on human development would give larger scope to human freedom by providing a rational basis for option and action. Man makes himself through enlightened choices that enhance his humanness." Working out these choices -- the principal task of the system laboratories -- depends to a large extent on a deeper knowledge of the living experience. Thus, the system laboratories will spur the formulation of function-oriented departments in many fields of investigation which have so far received little or no attention.

In dealing competently with their tasks, the system laboratories may gradually lead the university away from its present fixation on the physical sciences and technology. As René Dubos[1] states, "the creativeness of life always transcends the imaginings of scholars, theologists, and science fiction writers..... To be humanly successful, the new ages will have to overcome the present intoxication with the use of power for the conquest of the cosmos, and to rise above the simple-minded and degrading concept of man as a machine. The first move toward a richer and more human philosophy of life should be to rediscover man's partnership with nature." Technology will not play the first role in such a partnership:".... the view that man's future is linked to technology can become dangerous if accepted uncritically. Any discussion of the future must take into account the inexorable biological limitations of homo sapiens." This statement, again, emphasizes strongly the need for a university capable of continuous self-renewal, and not of the preservation of existing modes of human

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[1] René Dubos, So Human an Animal, Scribner, New York, 1968.

expression and creativity.

But the quotation from Dubos' book also points to another aspect. Dealing with the "joint systems" of society and technology will be but a beginning. The more important domaine for investigation and for system engineering -- and perhaps the crucial determining factor of social systems -- may be recognized in individual man/technology, man/nature, and man/society systems.[1]

René Dubos[2] points out the complex, multiple-loop feedback interaction in the development of the human species, linking evolutionary development, experiential development, and human free will. The man/environment interaction determines which part of the genetic endowment is brought into play, becoming visible as human adaptivity to new environments. At the same time, this endowment determines the boundary lines for man's adaptivity and free choice. But human free will also changes the environment and thereby affects experiential development.[3]

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1 For a brief discussion of this problem see: Erich Jantsch, Integrative Planning of Technology, in Perspectives of Planning, O.E.C.D., Paris, 1969.

2 René Dubos, So Human an Animal, Scribner, New York, 1968.

3 The educational environment certainly plays a most important role in this feedback.

This complex feedback system for the individual is no less in danger to develop in uncontrolled and wrong directions than the systems of society. The university must maintain its flexibility to accept this new challenge of individual systems as it goes along in developing its approaches to social systems.

It goes beyond the scope of this paper to elaborate in detail possible designs and activities of future system laboratories. This ought to be the subject of a series of detailed studies in various focal areas. Some of these focal areas are already becoming more widely recognized today, for example:

-- Physical environmental systems, and man/environment systems, emphasizing the preservation and restoration of land, water, and air.

-- Ecological systems in natural and man-made environments, which may be studied in two separate system laboratories.

-- Systems of urban living,[1] taken in the broad meaning implied by C. A. Doxiadis' "ekistics" (embracing the principal dimensions nature, man, society, shell, and networks).

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[1] It may be noted in this context that a massive inter-university attack on urban problems, taking a system engineering approach, has been urged by Hubert H. Humphrey at a panel discussion, held at M.I.T. on 17 April 1969.

-- Health systems,[1] with emphasis on creating the conditions for positive health, not organizing counter-measures against the degradation of health in a modern world.

-- Natural resources, emphasizing natural production and recovery cycles, upgrading (such as breeding fissile from fertile nuclear material), new sources, and optimal use of scarce materials.

-- Food systems at a global scale, stressing production (including the possible need for the introduction of new forms of non-agricultural food production technology, such as Single Cell Protein), distribution and utilization in a broad socio-economic context.

-- Product/waste cycles, investigating alternatives to the current massive introduction of one-way, non-degradable products.

-- Communication/transportation systems.

-- Information/communication systems, emphasizing aspects of tremendous future importance, such as privacy, accessibility of information systems to the individual (for example, for self-education and studies), filtering of information, etc.

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[1] In a panel discussion, held at M.I.T. on 23 April 1969, John W. Gardner, former Secretary of Health, Education, and Welfare, stated that it was not possible to speak of an existing health system in the United States today. A joint M.I.T./Harvard center, expected to start operating in the academic year 1969/70, will focus on aspects of a potential U.S. Public Health System.

-- <u>Population</u> at a global scale, and system approaches to the stabilization of current growth trends.

-- <u>Education systems</u>, in particular with respect to the increasing need and challenge for life-long education.

-- <u>Exploration</u>, including a system approach to space exploration (problems of extraterrestrial ecology, etc.).

-- <u>International systems</u>, how they are affected by political, social, monetary, economic, and technological disparities, and how they could be redesigned in an imaginative way.[1]

-- <u>Defense systems</u>[2] would, in principle, also belong here as long as defense is recognized as inevitable theme for society. However, since any classified work will have a disruptive effect on the unity of the education, research,

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[1] The current single-track approach to problem areas such as foreign policy, development, monetary and economic cooperation, disarmament, technological gaps, etc., proves to be particularly harmful. For further elaboration of this theme, see, for example: Aurelio Peccei, <u>The Chasm Ahead</u>, Macmillan, New York, 1969.

[2] It may be noted here that a system engineering task -- creating SAGE, a continental air defense system -- led to the establishment of M.I.T.'s Lincoln Laboratory which, at present, is still an integral part of M.I.T. in a juridical sense, but has become almost completely "alienated" from M.I.T.'s education and research functions. However, the engineering of SAGE may still serve as example for an <u>active</u> engagement of the university in system engineering, in contrast to "engineering to order". It is reported that SAGE has first been bitterly attacked by the military establishment and considered an undue "intervention" of university.

and service functions, system engineering in this area may perhaps best focus on such problems which are openly discussed and which belong to the interface of foreign policy and defense (including, for example, the "nuclear balance" between the superpowers) and to the interface between defense and economics (disarmament, reconversion of industry and of people, etc.).

It will be of special importance that universities become active in the engineering of systems which either transgress current jurisdictional boundaries -- and thereby give rise to changes in these boundaries (e.g., for the types of "megalopolis", forming at present) -- or are of global nature. It is in these areas that new imaginative approaches are most urgently needed.

The future system laboratory, as it is sketched here, will be software-oriented and incorporate a high degree of flexibility, because each of the "social system engineers" will participate in its work not as a specialist, but will try to take an integrative approach also as an individual. It will therefore be a natural place for the "new corporate design", as outlined by Jay Forrester[1] -- emphasizing profit centers at the level of individual action instead of the traditional superior/subordinate relationship, radial instead of mesh-type information systems, etc.

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[1] Jay W. Forrester, A New Corporate Design, Industrial Management Review, Vol. 7, No. 1, Fall 1965; reprinted in Perspectives of Planning, O.E.C.D., Paris, 1969.

In accordance with such a design, the traditional professor/ student relationship will be abolished. There will be more permanent senior people, and they will, in most cases, form new "profit-centers" (venturing new tasks). And there will be a continuous through-flow of people working full- or part-time for "profit-centers" (system engineering projects) of their choice. One may recognize in the former "faculty", and in the latter "students" or "professionals" (temporarily back at the university to go through part of their life-long education), but these distinctions will not matter very much.[1] All participants in individual "profit-centers" will earn money in relation to the work they offer to contribute, and the effectiveness with which they carry it out.

There will be no grades given for this type of work. Rather, the total experience will be judged, as it is done in industry for the promotion of careers. It will be possible to fulfill Master's and PhD requirements in the framework of such team work rather than in seclusion and by one-man research tasks.

One may view the education of "social system engineers" with Forrester[2] as a special line of education, requiring approximately

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1 An imaginative approach along similar lines has been introduced in the medical school of Hitipi University in Turkey.

2 Jay W. Forrester, Engineering Education and Engineering Practice in the Year 2000, paper presented to the National Academy of Engineering, 21 September 1967, at the University of Michigan; to be published by the Academy.

ten years, and given to the average student between age 17 and 27. One may believe in the approach of Bell Telephone Laboratories, where "system engineers" are scientists and engineers mature in both age and skills, entering the system phase of their career in succession to having worked as specialist-scientists and engineers. However, the approach suggested by this paper -- the integration of "social system engineering" education into the overall university system -- would clearly be the most desirable, if its feasibility can be proven. It would also permit students to decide during their studies whether they wish to pursue their career by meeting this most demanding challenge to intellectuals.

Forrester[1] estimates that an equilibrium of approximately 75 per cent work and 25 per cent study will be reached at age 27, and roughly maintained thereafter for a system engineer. The learning phase, spent in the system laboratories, will be characterized by this predominance of work over study. Study, in turn, will be mainly self-education and "browsing" through all kinds of information systems (from shelf libraries to computer-storage system) for knowledge recognized as relevant to the specific type of work done. Some of it will be direct "tutorial aid" by "faculty", but at least for a transitory period, "faculty", too, will have a greater need to learn than to teach.

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[1] Jay W. Forrester, Engineering Education and Engineering Practice in the Year 2000.

There are few real masters of system engineering, even for the relatively narrow concepts of system engineering applied today.[1] This makes it more imperative to start early with pilot laboratories.

II.4. The Organization of Function-Oriented Departments

If the system laboratories take a system engineering approach, the function-oriented departments may be characterized by a basic system analysis approach -- but in the same multidisciplinary and integrative spirit, preparing the elements and subsystems for the engineering work of the system laboratories.

A few highly interesting experiments along this line are being currently undertaken in American universities, primarily geared to undergraduate education. The most prominent examples are the Irvine campus of the University of California, and the Green Bay campus of the University of Wisconsin.

It is very instructive to look in more detail at the Green Bay

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1 It is significant that M.I.T.'s Center for Advanced Engineering Study finds it most difficult to locate faculty for teaching a curriculum in system engineering, and that it was not possible to build this curriculum from existing subjects.

concept[1], which constitutes probably the most significant innovation in higher education introduced in the United States in the 1960's. Its basic philosophy has been stated as follows: "A student who is committed to the world in which he sees to learn and involved in its day-to-day activity is one for whom learning will have real purpose. Such a student becomes concerned for society and its improvement. When he also becomes involved in the world, through firsthand observation and experience during his years of academic preparation, he becomes a full participant in his education instead of the passive occupant of a classroom chair.... From the conviction that learning should be purposeful, that it should help to define individual values, that it should involve the student in the life of the world, has grown the special focus of the UWGB program: a focus on ecology, or the study of man in relation to his surroundings. Such an approach to knowledge becomes urgent in the face of the increasing complexity of unsolved problems of the physical and social environment."

An introductory program for freshmen brings two major concerns into focus: values and environment. In the framework of theme colleges, each undergraduate student must select a concentration (which term refers to an interdisciplinary focus on an environmental problem), and may select an option (which term refers to a disciplinary

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1 The University of Wisconsin, Green Bay, Catalog 1969-1970.

or field of knowledge emphasis). Professional collateral courses, concentrated in a School of Professional Studies and relating concentrations and options to special professional fields, ease the transition to graduate education in the traditional areas geared to current types of professional careers.

The UWGB Catalog for 1969/70 lists a number of highly imaginative educational structures from which to select (see Table II).

However, such an educational scheme does not go far enough. It does not attempt to impose its function-oriented structure upon "real life". Rather, it tries to motivate students during their undergraduate period sufficiently to let them bring this motivation, a new professional ethos and a certain propensity for generalization to a scheme of professions which is assumed more or less rigid. If the student's imagination is "opened up" in his undergraduate study, it is squeezed again into a conventional framework of professions in his graduate years.

In the scheme proposed by this paper, function-oriented departments would become the backbone of graduate education. This is felt to be the more justified since in advanced-thinking industry a process of change from product- or skill-oriented structures toward

Theme Colleges	Concentrations (Areas)	Options
The College of Environmental Sciences	- Environmental Control (Air, Water, Air/Water, Land, Land/Water, Natural Resources) - Ecosystem Analysis (Ecosystemology, Communities and Polulations, Physiological Ecology -- Environment Impact on Individual Organisms)	Earth Sciences, Mathematics, Chemistry, Physics, Professional Programs, Agricultural Science, Engineering, Hydrology and Water Resources
The College of Human Biology	- Human Development (Physical Growth and Development, Mental Growth and Development) - Human Adaptability (Chemistry, Physics, Mathematics, Biology, Anthropology, Psychology) - Human Performance - Nutritional Science - Population Dynamics	Biology, Professional Programs, Human Economics, Dentistry, Medicine, Veterinary Medicine and Veterinary Science, Medical Technology, Pharmacy
The College of Community Sciences	- Regional Analysis - Urban Analysis - Modernization Processes	Anthropology, Economics, Geography, Political Science, Psychology, Sociology
The College of Creative Communication	- Analysis/Synthesis (Evaluation, Opinion Formation) - Communication/Action (Expression, Influence)	Communication Sciences, Literature and Language, Creative Use of Other Languages, History, Philosophy, Visual Arts, Performing Arts, Music

Table II. Undergraduate Education at the University of Wisconsin - Green Bay. The term concentration refers to an interdisciplinary focus on an environmental problem. Part of the credit in the framework of concentrations may be earned in alternative areas. The term option refers to a disciplinary or field of knowledge emphasis within a concentration. Each student must select a concentration and may select an option. (Source: The University of Wisconsin, Green Bay, Catalog 1969-1970).

function-oriented structures has already begun.[1] This change has been stimulated by the adoption of the concept of corporate long-range planning. To an increasing extent, the professions of the future will be defined in such function-oriented categories. At the same time, governmental planning is being transformed in the United States to the function-oriented framework of the Planning-Programming-Budgeting System (PPBS).

Most of the engineering disciplines will become "dissolved" in new function-oriented departments. Occasionally, a discipline-oriented department may be expected to split off. To give an example, a current broad Department of Electrical Engineering may be partially involved in many function-oriented activities, such as: power generation, distribution, transmission and utilization; communication; automation and process control; information-technology; education technology; medical technology; and so forth. It may also comprise important activities in basic disciplines such as computer science, material science, physics, chemistry, etc. It will become logical to create

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[1] An illustrative example may be found in electrotechnical industry, where the traditional structures, composed of steam turbine, gas turbine, generator, transformer, cable divisions etc., are changed to structures focusing on power generation, power distribution and transmission, power utilization, etc. The petroleum companies are redefining their purposes from the exploitation of resources and skills to functions (energy for transportation, etc.); the pharmaceutical corporations are becoming more deeply involved in human biology in a very broad sense, agricultural chemical corporations in problems of ecology, etc.

function-oriented departments under the headings outlined above, and possibly create a new computer science department, which would then be conceived as a discipline-oriented department. In the same way, a department of nuclear engineering may become "dissolved" in a power generation department and a new discipline-oriented reactor science department.

The main purpose for such a thorough restructuring of engineering education is three-fold: First, by focusing on outcomes (consequences) rather than on inputs and methods, it brings the potentials of choice and priority, i.e. of values, into play; second, it opens the view into the long-range future by keeping alternative technological options open; and third, it makes an integrative approach possible, in particular the enrichment of the engineering professions by social, economic, and psychological dimensions. To achieve this three-fold purpose, the newly formed function-oriented departments will, of course, be much more than just pieces of old structures.

The most important lines of communication for these function-oriented departments will link them vertically to various discipline-oriented departments as well as to various system laboratories. The horizontal ties among function-oriented departments will, of course, tend to be relatively weak, but may nevertheless be expected to become reinforced through the interdisciplinary and interfunctional guidance provided by the system laboratories. Also, various function-oriented departments will normally contribute to individual projects of the system laboratories. System engineering in the area of systems of urban living, for example, will need inputs from many sides: communication technology, transportation technology, architecture, information technology, education technology, and what is called at Green Bay the community sciences in general.

In the framework of these departments, important developments in what may be called the methodology of social system management will have to be undertaken. In particular, social system analysis concepts and utility concepts permitting comparison of outcomes in terms of "social system effectiveness" are needed. Possibly, a separate "social management" department may be envisaged to stimulate, combine and refine such methodological developments. It would focus on the development of an entirely new body of knowledge, which may be called the economics of socio-politico-technological systems -- a challenge not, or barely, accepted by the conventional departments of economics and political science.[1] This may constitute the most urgently needed breakthrough and a real hope to get away from the growth syndromes and materialistic utility concepts of conventional economics and politics.

Another important task for the function-oriented departments will be the forecasting and planning of strategic options, in particular

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[1] Although set up in the framework of the country's foremost technical university, M.I.T.'s Departments of Economics and of Political Science remain generally untouched by, and unconcerned about, the problems of the interactions between technology and society.

technological options, in the framework of long-range planning at the level of society. This will probably become the primary service function for this type of department. It can accept this task, because it is outcome-oriented and will assess alternative technologies on the basis of their overall effectiveness in social systems. This should contribute to breaking up linear technological growth and to make a more rational selection of future developments.

The education function will probably favour a mixture of lectures, seminars, purposeful work and self-education. Purposeful work will be less dominant than in the system laboratories, and take up about 30 to 50 per cent of the study time. Students will normally participate in purposeful team work as well as concentrate on two or three areas of their choice -- including the possibility of deepening their understanding of basic disciplines and doing part of their studies in discipline-oriented departments.

The function-oriented department will become the center for work geared to the Master's degree, at least in all engineering and some social science areas. Students not going through the system laboratories, will leave the university as "stationary engineers" for social systems (to use Forrester's terms) -- but they will know how to interact with and build for these systems in an integrative way, they will be long-range alert and outcome aware, and they will acquire a feeling for the "reality value" of these long-range outcomes and feel compell l to act in a responsible way.

This is the deeper concern which makes the establishment of function-oriented departments so urgent, in spite of the shortness of sufficiently broadminded faculty and of the far-reaching consequences of such a major reshaping of university structures and curricula which have been so successful in the past. Here lies our best, and possibly last, chance to take seriously and to substantiate our own forecasts for the medium- and long-range future -- and to take action. If the students, leaving the university in the middle 1970's, will not have been able to acquire this propensity, our chance of shaping the future actively in this century may well be lost to overpowering forces beyond our control.

II.5. The Organization of Discipline-Oriented Departments

The present university structure depends mainly on departments oriented toward scientific disciplines or multi-disciplinary compounds in certain areas of technology, or also toward broad technological skills such as mechanical or electrical engineering. The principal approach in the engineering disciplines is that of teaching "know-how"-- a reductionist approach which is also, to an increasing extent, entering the departments of the physical, social, and the life sciences (in particular medicine).

The approach of the future, as required in the framework outlined here, will focus on "know-why". This is essential if the disciplines are to provide the elements for a function-oriented approach and ultimately for designing new systems between man, society, nature, and technology.

What is meant by this new approach of "know-why" may be best illustrated by two quotations from René Dubos[1] pertaining to a complete reorientation of the life and social sciences: "A new kind of knowledge is needed to unravel the nature of the cohesive forces that maintain man in an integrated state, physically, psychologically, and socially, and enable him to relate successfully to his surroundings. Hardly anything is known of his adaptive potentialities, of the manner in which he responds to the stimuli which impinge on him early in his development and throughout his life, and the long-range consequences of these responses not only for himself but for his descendants. These and other countless problems of human life should and could be studied scientifically yet have hardly any place in the curriculums of universities or research institutes."

This "know-why" does not passively provide elements for building new systems, but is linked to the socio-technological and human-technological system engineering task in a feedback loop of the highest importance. To state this again in Dubos' words: "Conducing science into human life enlarges the scope of freedom and responsibility. In most cases, choices and decisions have to be made on the basis of

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1 René Dubos, So Human an Animal, Scribner, New York, 1968.

value judgments which transcend knowledge and involve not only the here and now but also anticipations of the future. Scientific understanding helps in predicting the likely consequences of social and technological practices; it provides a more rational basis for option. Since awareness of consequences usually plays a part in decision-making, scientific knowledge could become one of the criteria for the acceptance or rejection of old value systems, and even for the development of new ones."

The development of scientific knowledge in the framework of established disciplines may thus be viewed as an integral element of the supreme task of system engineering. It would not only be valuable for the preservation and enrichment of bodies of scientific knowledge and their organizing principles (theories), but also attain direct significance in relation to man and society. Such significance may conceivably also be developed for many of the physical sciences.

II.6. Institutional Ties Between the University and Society

It has already been stated above that the university of the future ought to become a political institution in the broadest meaning of the term, participating in the political planning process and contributing to the decision-making process. "The wisdom represented in the government is but a small fraction of the wisdom available in the people", stated Isidor Rabi recently.

If the three functions of the university -- education, research, and service -- are to be approached in a unified way and thereby given a new significance, the university has to become involved as an institution, not only through the individual members of its community. The consequences of such a new orientation and purpose will be far-reaching. It will not be easy for the university to maintain its vitality and continuously renew itself in the erosive political process. For the first time the university will expose itself to full public criticism, and initially suffer considerable shock from the sudden loss of its protection behind the faceless mask of "objective" science. However, there does not seem to be any alternative if an ecological approach to science and technology is considered mandatory, as indeed it has to be.

The top criterion for defining the boundaries of the institution of the university is the unity of the education, research, and service functions. Other approaches to research and service may be conceived and set up by the university outside its institutional boundaries, for example, in the form of not-for-profit organizations; they cannot form an integral part of the university.

On the other hand, the university ought to deal effectively with those service aspects which do fall within the institutional boundaries by the above criterion. This may lead to the concept of a university corporation, marketing and selling these services on behalf of the university. The principal idea behind such a concept would be not only a concentrated approach to the management of the various services which the university is currently performing, but the potential of financial independence on the strength of the service function. A prerequisite would be a more realistic assessment of the value of these services to society.

Today, university service in the form of education and research is grossly underpaid. This gives various parts of society, and in particular government at the federal and state level an almost authoritarian hold on the university, which tends to enhance the current passive role of the latter. Through charity, grants, and piecemeal contracts the university is tied to purposes which are neither its own nor the proper purposes of a self-renewing society. This dependence is further enhanced by deliberate "blackmailing" on the part of government, which couples support of some of the university's "hobby-horses", mainly in basic research areas, with compliance in fields of applied research and engineering.

The strive toward financial independence of the university ought to focus on two major objectives:

- -- Becoming master of its own internal science policy with full freedom to select and fund its educational and research objectives not only in the system engineering, but also in function-oriented and basic research areas; and

-- Providing graduate and postgraduate education tuition-free[1] by involving students in useful work (instead of providing charity for them in the form of fellowships, etc.).

The first one of these objectives carries the potential of providing the badly reeded breakthrough to a more rational and pluralistic science policy in the "new spirit" -- not policy for science, but policy through science. We witness today a science policy moving in a vicious circle characterized by the inability of the Federal government to formulate purposes and priorities and to translate them into the terms of science and technology, and the control of important funds by the same government. It is significant that the ideas for improving U. S. science policy, as they are aired at present[2], all converge on some big instrumental government agency, which in fact would revert the current tedious process of rationalization by such schemes as the Planning-Programming-Budgeting System (PPBS): A cabinet-level Department of Science Education, and Cultural Affairs; a cabinet-level Department of

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[1] From the viewpoint of society, undergraduate education, too, ought to be free if the principle of equal educational opportunity is to be maintained. But to the extent that undergraduate students are learning in other ways than through participation in useful work, this burden should not be borne by the university, but by society.

[2] Representative Emilio Q. Daddario, Chairman of House Committee on Science, Research and Development, in the Ferguson Lecture for 1969 at Washington University in St. Louis, as reported in: The Dulcet Voice of Culture, Technology Review, April, 1969. Rep. Daddario himself does not align himself with any of these ideas for a large-scale instrumental institution for science.

Science and Higher Education; a loose confederation of federal agencies (a "General Services Administration for Science"); a statutory Council of Advisers on Science and Education; a revamping of the Office of Science and Technology which would broaden and strengthen it.

"We need something better," states William Carey,[1] "something capable of shaping science goals and strategies with depth and range and visibility.... What I visualize is a center for examining the interaction of science with higher education, social change, international cooperation, technological development, and economic growth. It would be a center to examine the mix of national investment in science and technology, to assess the quality and social returns of the investment, to identify opportunities and imbalances, to formulate models for investment that are addressed rationally to the variety of needs that we face -- in short, to make a start toward indicative planning of the uses of science and technology."

It is inconceivable that this task be carried out without bringing the full potential of scientific knowledge and ideas, in other word the potential of the university, into the planning process. <u>The university has to become the basic unit in a decentralized, pluralistic process</u>

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[1] William D. Carey, Toward the Proper Study of Man, <u>Technology Review</u>, March, 1969.

<u>of shaping the national -- and, beyond that, a future global -- science policy</u>. It has to tie in with a common policy for society, participate in the competitive process of formulating strategies, but be fully responsible for its own tactics which include the support of basic science and the development of technological skills.

The institution envisaged by Carey, may be set up as an inter-university institution, roughly of the type originally conceived for the Institute of Defense Analyses (IDA), which may become the "melting pot" and the center for the synthesis of the major universities of the country. It would resemble the horizontal staff group at strategic level, as it is found in industrial corporations today for the integrative planning in the framework of the corporation. It would provide a "strategic antenna" oriented toward society's values as well as toward the future. It would force government to formulate an overall policy, and it would stimulate contributions from the universities backing the institution. It would guide socio-technological system engineering by giving it the proper framework.

The university will have to maintain close connection with many organizational elements of society, not just the Federal Government, but with government at all jurisdictional levels, with research institutes, and with industry. The university-corporation will have the task of maintaining the information flow in the triangle, government - industry - university, as well as of negotiating the interactions between the university and its partners in it. Such interactions may include consortia, joint ventures, prime and sub-contracting, consultancies, etc., with government, industry, other universities, and research institutes.

The system laboratories will lead this process through the university corporation in most cases, but more analytical jobs may be contracted with government and industry on behalf of the function-oriented departments, and contributions of basic science on behalf of the discipline-oriented departments.

Conceivably, the university will also provide methodological aid to both government and industry, possibly through broad horizontal institutes resembling, somewhat, the recently established "Institute for the Future" whose first research center lives in symbiosis with Wesleyan University.

The task of turning the university from a passive servant of various elements of society and of individual and even egoistic ambitions of the members of its community into an active institution in the political planning process -- the process of planning for society-- implies profound change in purpose, thought, institutional and individual behavior. It will give the university freedom, dignity, and significance -- qualities which have become grossly distorted in a process in which the university is used, but is not expected and not permitted to participate actively.

CHAPTER III. FIRST STEPS TOWARD A RECONVERSION OF THE UNIVERSITY

The university is in a unique position to start the process of institutional change in society, because it can educate the "careful rebels" needed for this task. However, the most serious obstacle is the lack of faculty capable of leading this reconversion process. Therefore, it is urgent to start it and to turn the university into its prime mover. This chapter attempts to outline a few positive steps which may be taken almost immediately by the present university.

It will not be easy to reconvert the old university, and the question may be asked whether it would not be desirable to build entirely new institutions instead of changing the old ones. The principal reason speaking for reconversion is time. If experiments are set up to supplement and gradually replace the existing universities, the transition would take too long. The inertia of the present education system, if it is permitted to carry on in its usual way, would lead society straight into catastrophe. Also, if the opinion is held -- as it is in this paper -- that the rebellion of the young against current social values is not merely a passing phenomenon of unrest, but the start of a landslide which will bring tremendous change in thinking and behavior, the old university is in danger of being destroyed and leaving a fatal vacuum behind which cannot be filled by "law and order".

We have almost no choice but to try to abolish the old university as we go along building the new one -- in the framework of one and the same institution. The guiding strategy ought to be the creation of new structures which will be so entrepreneurial in spirit and so attractive to creative people, that the life is "sucked out" of the old structures, whether they will be permitted to continue or subsequently abolished. What is most needed in the present situation is a St. Augustin to build a new culture on the valuable fundamentals of the old one.

It may also be considered a good strategy to restructure PhD and undergraduate study first, and attack the "hard core" of specialized graduate study only after the softening-up process has made some impact.

It is important to get students and faculty gradually involved in this process as soon as possible. Time is already working against us. A reasonable time-scale may be conceived as follows:

1970	Start of reconversion process;
By 1975	A significant number of students, who had been involved in the early phases of this reconversion process, have finished their studies and have become active in society;
1975-1980	Accomplishment of the full task of structural change in the university;
1980-1985	The new university achieves its full impact upon society.

A 15-year time-frame to achieve the objectives of the reconversion process, may be considered short from the point of view of unprecedented institutional change it implies. But even at this pace, the required change will come very late -- possibly even too late -- to cope with the problems the world will face in the near future.

Concrete steps which may be taken to start the reconversion process of the university almost immediately, may include the following innovations easy to introduce into or attach to existing university structures:

(1) Pilot system laboratories, in particular focussing on the engineering of urban and health systems. These pilot laboratories will depend on the entrepreneurial spirit of their founders and animators. They may first offer possibilities for PhD thesis work, which would least effect existing educational schemes. In this context, an example provided by the University of Manitoba in Winnipeg may be of interest: The University accommodates various government laboratories for civilian research on its campus, and recognizes outstanding research workers as professors who are allowed to supervise PhD students working there. In addition, the University has a Vice President for Multi- and Inter-Disciplinary Studies whose task it is to conceive so-called "paper institutes" (institutes which exist only on paper, not in reality, and provide an administrative framework for integrative studies by people from all parts of the

university as well as for contracting out supplementary studies which cannot be carried out at the university).

(2) The gradual structural change of the engineering departments toward function-oriented structures. The theme colleges at the University of Wisconsin, Green Bay (see section II.4. above) provide an example for undergraduate education. The recent reformulation of engineering curricula at Stanford University gives another example for for graduate education. There, engineering studies are now split into fou parts of approximately equal size: in-depth study of one engineering field, general engineering, social sciences and humanities, and a group of freely selected subjects.

(3) Interdisciplinary centers for integrative studies and for policy studies, taking a very active attitude and developing consistent programs for which self-organized groups would be invited. Integrative studies, for which an example is provided by the Center for Integrative Studies at the State University of New York at Binghamton, may focus on integrative forecasting as well as on methodological development. Close cooperation with independent institutes such as the Institute for the Future may be sought. Policy studies may take a look at the role of the university in society and support government efforts in planning and in the development of the "methodological infrastructure" for the Planning-Program-

ming-Budgeting System (PPBS), including social system analysis and cost/effectiveness concepts.

(4) Strategic full-time staff groups in the university, guiding the formulation of future-oriented university policies and working out alternative transitional strategies. These staff groups may also direct the interdisciplinary centers outlined in point (3) above, and ensure their continuity and consistency in purpose by planning their programs in close contact with government and industry. They may also propose and manage joint projects with government and industry in areas where massive effort is urgently needed (e.g., urban systems, the World Food Problem, etc.). Also, they may link the university to possible future large-scale programs in problem areas of global nature, as well as to programs of international exchange in the area of system methodology.

(5) An inter-university center for strategic studies, located close to the Federal Government -- not quite the IDA-type institution envisaged in section II.6. above, but a place for interaction between strategic and future-oriented staff groups of the universities, and between the universities and government to "measure" the problem areas to be attacked by the universities.

(6) Special seminars and lecture series, emphasizing general themes such as "Science and Culture", "Science and Public

Policy", "The Science of Humanity", "Problems of World Futures", "Long-Range Integrative Planning", etc. They should be set up in such a way that they become an integral part of graduate rather than undergraduate study.

In the triangle of society's "science and technology managers" -- government, industry, and university -- the university is structurally the weakest element. In the United States, the Federal Government and some of the state and city governments have adopted a function-oriented framework for their planning (although in general not for their administrative structures), mainly in the framework of the Planning-Programming-Budgeting System (PPBS). Industry operating in areas of rapid technological change not only has adopted function-oriented and long-range planning, but is also in the process of converting its internal structures to match these functions. In addition, industry is well accustomed to have its long-range planning and its internal and external innovation processes guided by strategic staff groups, synthesizing inputs from all parts of the corporation. Some companies are even establishing special policy planning units looking at the changing role of their institution in a rapidly changing environment. The most streamlined corporations adapt themselves so as to be able to deal separately with the future and the present allowing to focus even more sharply on policies and strategies for the long-range future.

Only the university has not even made a start yet to prepare itself for an active role in shaping the future. The institution which has contributed so decisively to the acceleration of the dynamics in our society, is doing little or nothing now to guide these dynamics. This negligence, if allowed to continue, is not only threatening destruction to the university, but to mankind in general.

"Human freedom," states René Dubos[1], "includes the power to express innate potentialities, the ability to select among different options, and the willingness to accept responsibilities." The time is already very late for the university to renew itself in such a way that it may assume leadership in all three of those dimensions and thus become an institution for the enhancement of human freedom.

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[1] René Dubos, So Human an Animal, Scribner, New York, 1968.